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## MEMORANDUM

**DATE:** May 10, 2005

**TO:**  
**Howard Orlean (EPA)**  
**William D. Ernst (Boeing)**  
**Michael J. Gleason (Boeing)**

**FROM:** Geospatial Technical Working Group

**RE:** PCB Contouring Methodology for the South Boeing Plant 2 and  
Jorgensen Forge Waterfront Geospatial Analysis  
MCS# 340004.011

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This memorandum provides a description of the methods used in the geospatial interpolation of PCB concentrations in surface and subsurface sediments in the Duwamish Waterway adjacent to the South Boeing Plant 2 Southwest Yard and the Jorgensen Forge Waterfront property. Data from the Boeing Plant 2 Vertical Characterization of the Duwamish Sediment Other Area (DSOA), the Transformer Investigation, the Upriver (Area 1 Investigation), and the EPA Triad studies were used in a layered 2-D geospatial interpolation of Aroclor 1248, Aroclor 1254, Aroclor 1260, and total PCB concentrations. Dry weight Aroclor concentrations from EPA Method 8082 analysis were used in the interpolation and contouring. Total PCB concentrations were summed using the SMS rules.

These geospatial analyses were conducted solely for the purposes of aiding in the development of an upriver boundary for the DSOA. The results of these analyses are not intended to be used for any remedial design activities.

### DATA FILES

Surface samples were collected using grab samplers (van Veen) and hand-collection methods. Subsurface samples were collected using cores. Cores were typically segmented into 1-foot sections and identified by the depth interval (i.e., 0-ft to 1-ft, 1-ft to 2-ft, 2-ft to 3-ft segment). Only selected core segments were initially analyzed from each core. PCB and Aroclor values for

depth intervals that were not collected were assigned surrogate values using the following fill-down methods.

- ◆ Deeper core segments missing analytical values were filled in by carrying down the analyte concentration of the next shallowest segment analyzed.
- ◆ If a deeper sample had a higher concentration (concentration increases with depth), the higher concentration was not filled up.
- ◆ Surface or shallow subsurface samples were not assigned surrogate concentrations based on a deeper sample result.
- ◆ The data file was filled down to the 4- to 5-foot segment even if the deeper core segments were not collected.
- ◆ Sample points for each 2-D layer were coded on the figures as actual (filled circles) and filled in or surrogate (triangles) data. Filled data is identified as extrapolated on the geospatial interpolation figures legend.

Multiple cores or grabs collected at a single station and identified as field duplicates were offset by a minimum of 1 foot and were plotted as separate data points. Field splits (homogenized sample divided into 2 samples and analyzed separately) were assigned the higher concentration value.

Geospatial interpolation was conducted using the reporting limit for undetected Aroclors.

Underlying database files are available on the included CD-ROM.

## **SEARCH NEIGHBORHOOD PARAMETERS**

In several meetings, the technical work group developed consensus parameters, which follow. The geospatial analysis used Inverse Distance Weighting (IDW) on a 10-foot by 10-foot grid. The following search neighborhood parameters were used in the geospatial interpolation. The South Boeing Plant 2 and the Jorgensen Forge Waterfront area were divided into three subareas during the analysis to accommodate differences in the data density and the river channel orientation. (Note that the nomenclature used here is distinct from, and should not be confused with, earlier references to Area I, Area A, etc., referring to the zones where various parties were collecting samples.) The number of sample locations adjacent to the Southwest Yard at Boeing Plant 2 (Area 1) is less than the number of samples adjacent to the Jorgensen Forge property. The size of the search ellipse was increased to 150 feet and 75 feet (major and minor axes, respectively) for the geospatial interpolation adjacent to the Boeing Southwest Yard. The search ellipse was oriented parallel with the river flow (147.5 °N). The search ellipses used in Area 2 and Area 3 adjacent to

the Jorgensen Forge property were smaller (100 ft and 50 ft for major and minor axes, respectively) and oriented at 147.5 °N (Area 2) and 166 °N (Area 3) (Figure 1).

The orientation and size of the search ellipse controls which neighboring points are used in the interpolation of each grid value. The search ellipse orientation is independent of the north-south grid-cell orientation (established by default). Each search ellipse around a grid cell required a minimum of 2 neighbors (up to a maximum of 100) within the search ellipse for interpolation of a grid-cell value. A buffer zone of 50 feet was used between Areas 1 and 2 and 100 feet between Areas 2 and 3. Interpolated values for each grid cell were averaged within the buffer areas.

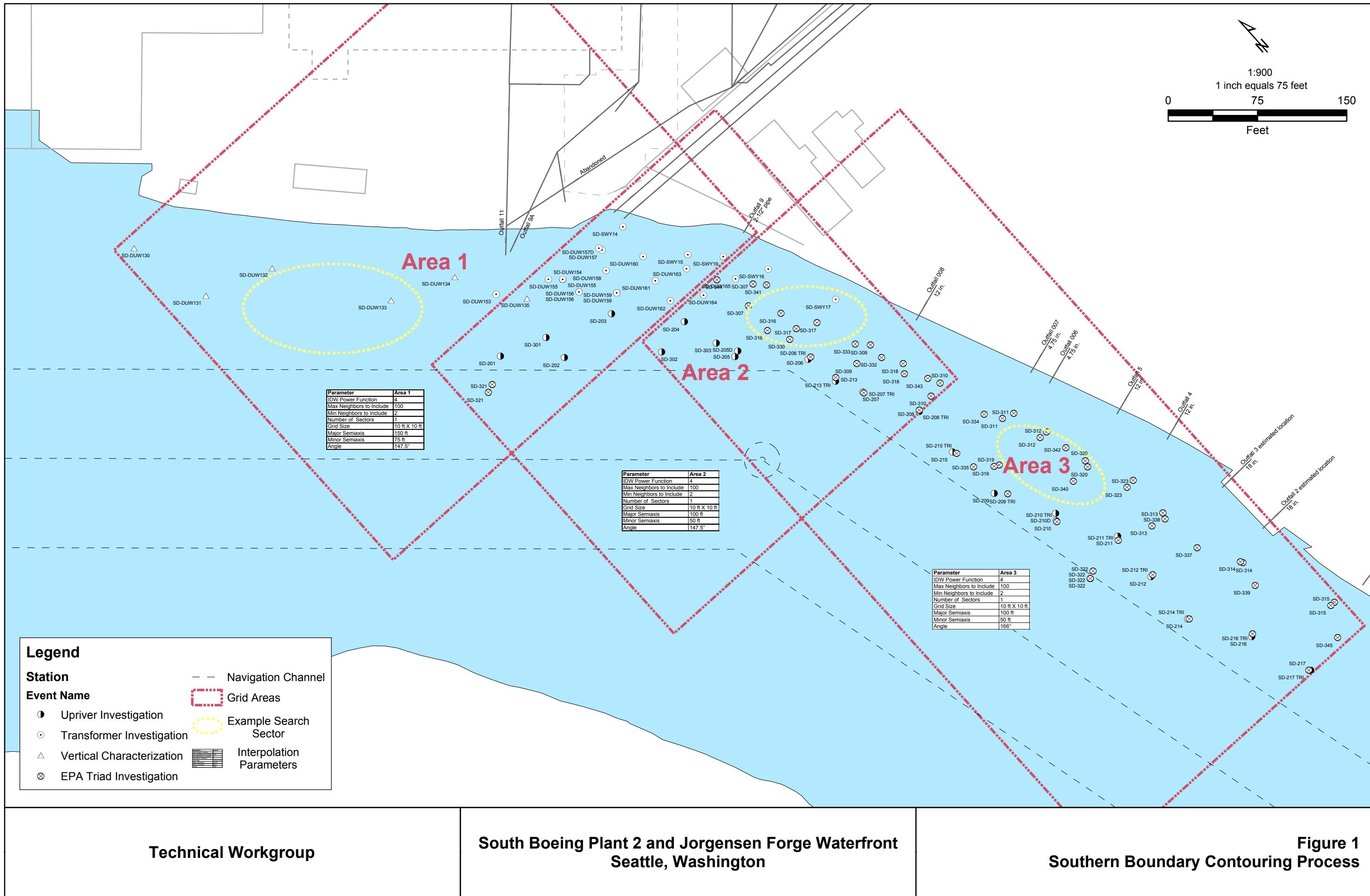
Power in IDW controls the influence that neighboring points have on the interpolated values of a grid cell. In IDW interpolation the influence of a neighboring point decreases with distance. Higher powers (2 and above) place increasing emphasis on the nearest points. A localized hot spot may unduly influence the interpolated value of surrounding grid cells at lower powers. Using a higher power (e.g., power of 4 used in this interpolation) reduces the number of stations where there is a noticeable difference between the interpolated value of a grid cell and an actual sample result within a grid cell (i.e., miscoding). Figure 2 illustrates the effect of different powers on a geospatial interpolation and provides examples of miscoding for a limited dataset.

## GEOSPATIAL INTERPOLATIONS

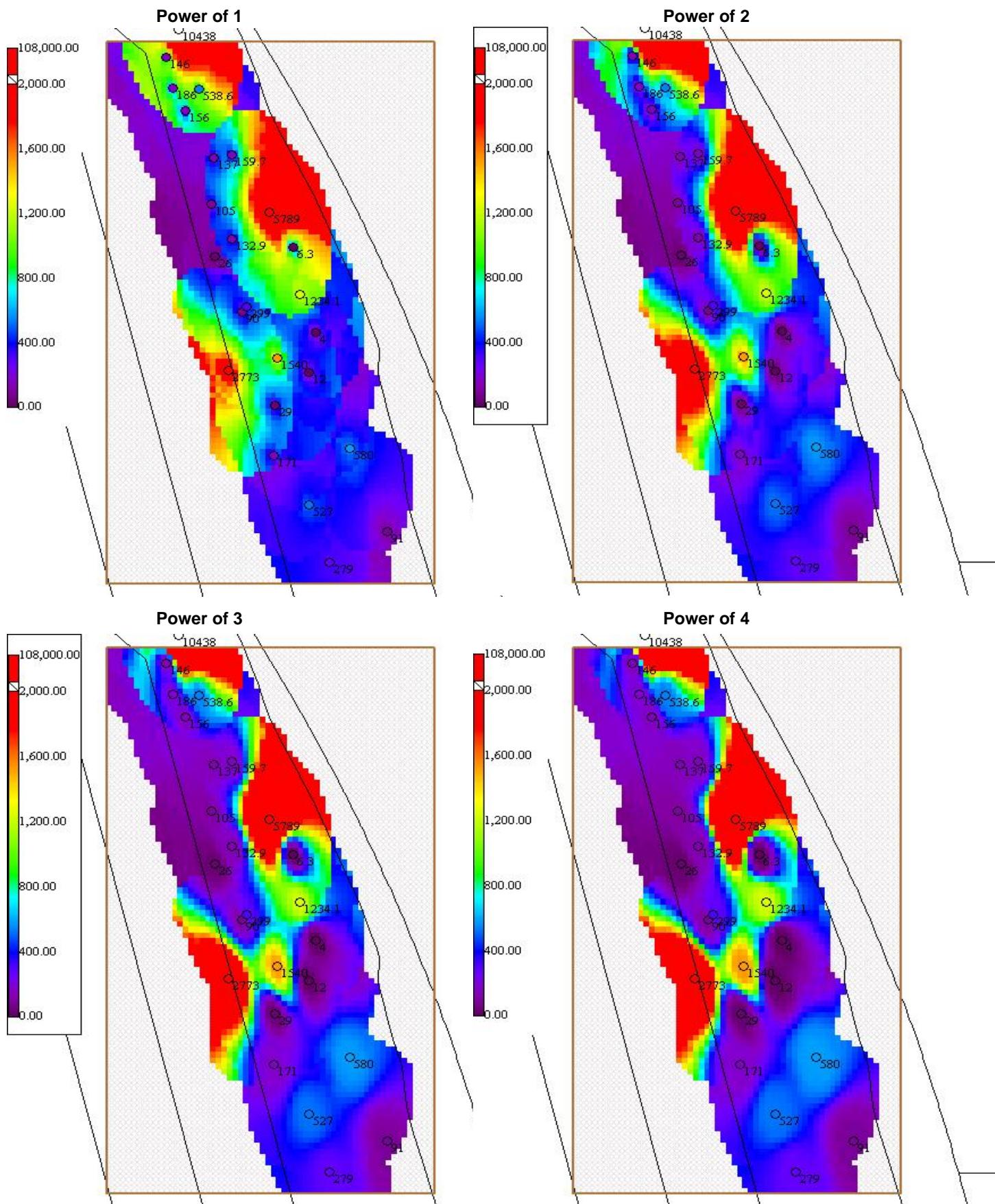
Geospatial interpolations were made using the surface, 0-1 ft, 1-2 ft, 2-3 ft, 3-4 ft, and 4-5 ft results for selected Aroclors and total PCBs. The number of sampling locations with actual data below 5 feet was limited. Cores were not driven below 5 feet at several locations. Samples below 5 feet were seldom analyzed if shallower samples were below the SQS. In addition, deeper layers did not show interpolated concentrations that were significantly different from the 4- to 5-foot results. The following geospatial interpolations are presented:

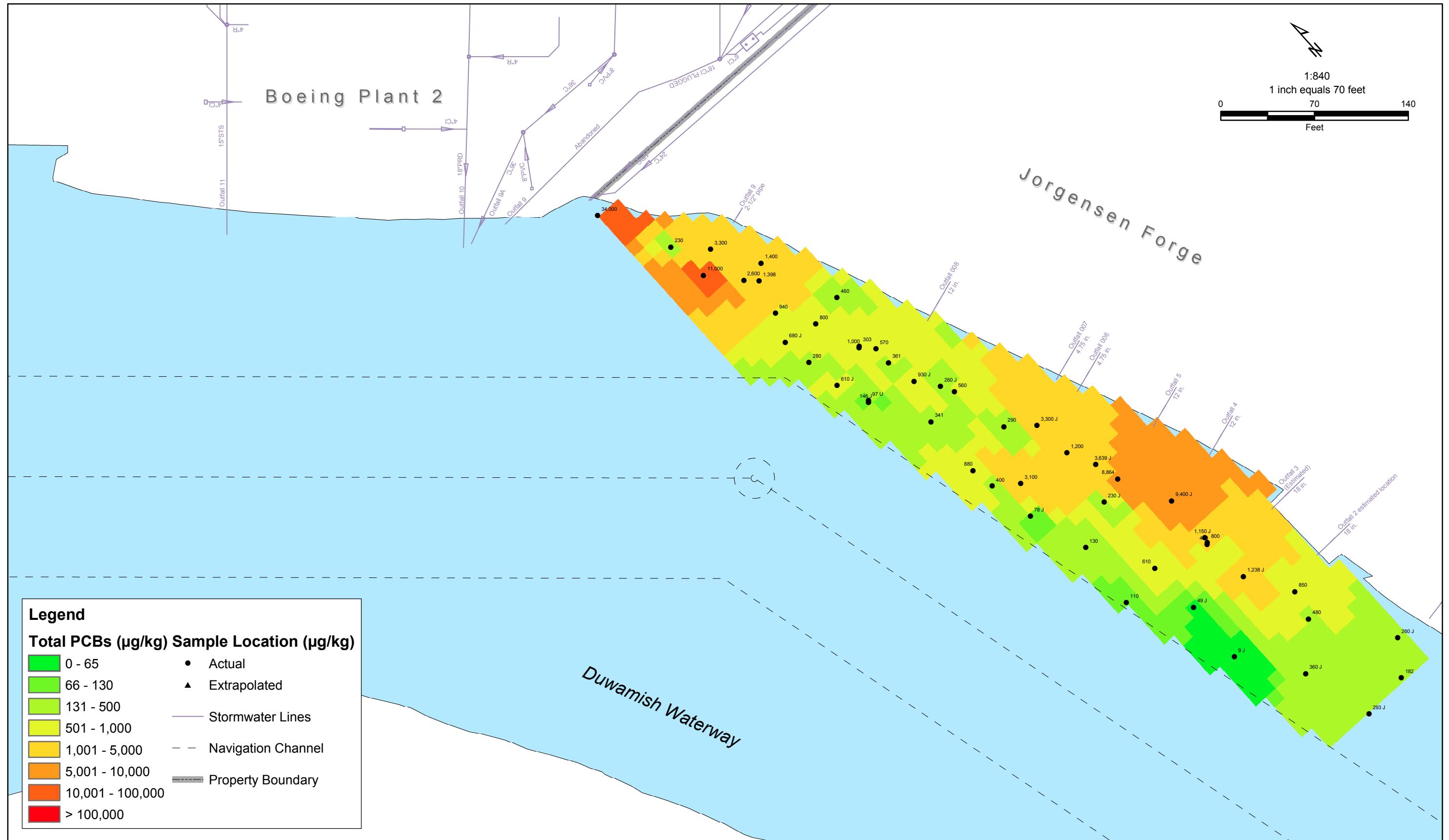
- ◆ 2-D layered interpolations of surface, 0-1 ft, 1-2 ft, 2-3 ft, 3-4 ft, and 4-5 ft results for Aroclor 1248 expressed as a percentage of the total PCBs. Aroclor 1248 concentrations expressed as ppb dry weight is not presented because of elevated detection limits for Aroclor 1248 in some samples.
- ◆ 2-D layered interpolations of surface, 0-1 ft, 1-2 ft, 2-3 ft, 3-4 ft, and 4-5 ft results for Aroclor 1254 expressed as a percentage of the total PCBs.
- ◆ 2-D layered interpolations of surface, 0-1 ft, 1-2 ft, 2-3 ft, 3-4 ft, and 4-5 ft results for Aroclor 1260 expressed as a percentage of the total PCBs.
- ◆ 2-D layered interpolations of surface, 0-1 ft, 1-2 ft, 2-3 ft, 3-4 ft, and 4-5 ft results for Aroclor 1254 expressed as ppb dry weight.

- ◆ 2-D layered interpolations of surface, 0-1 ft, 1-2 ft, 2-3 ft, 3-4 ft, and 4-5 ft results for Aroclor 1260 expressed as ppb dry weight.
- ◆ 2-D layered interpolations of surface, 0-1 ft, 1-2 ft, 2-3 ft, 3-4 ft, and 4-5 ft results for total PCBs expressed as ppb dry weight.
- ◆ Maximum value of Aroclor 1248, Aroclor 1254, Aroclor 1260, and total PCBs at any depth.



**Figure 2 Example of Effects of Power on Geospatial Interpolation Using a Limited Dataset.**

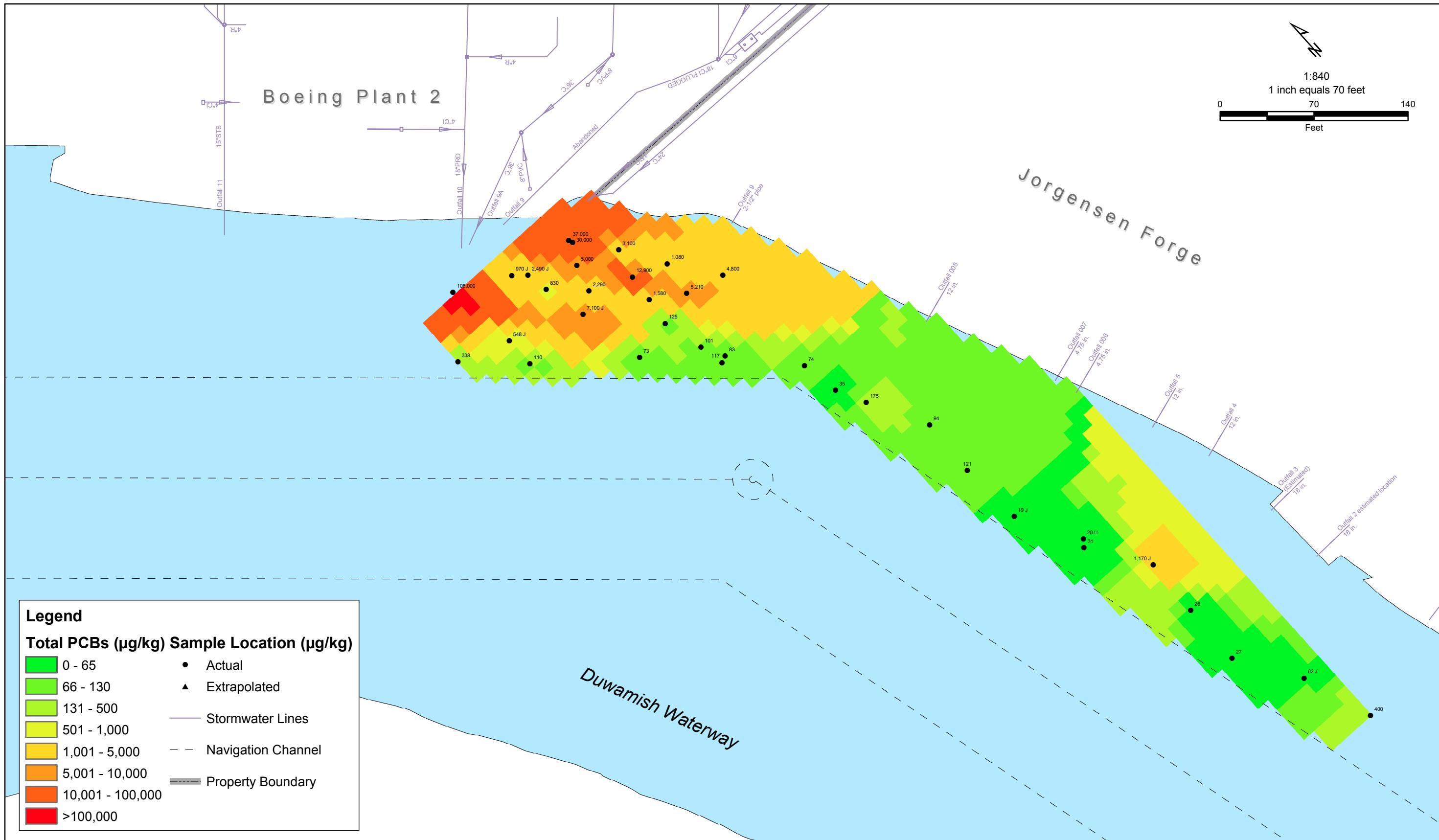


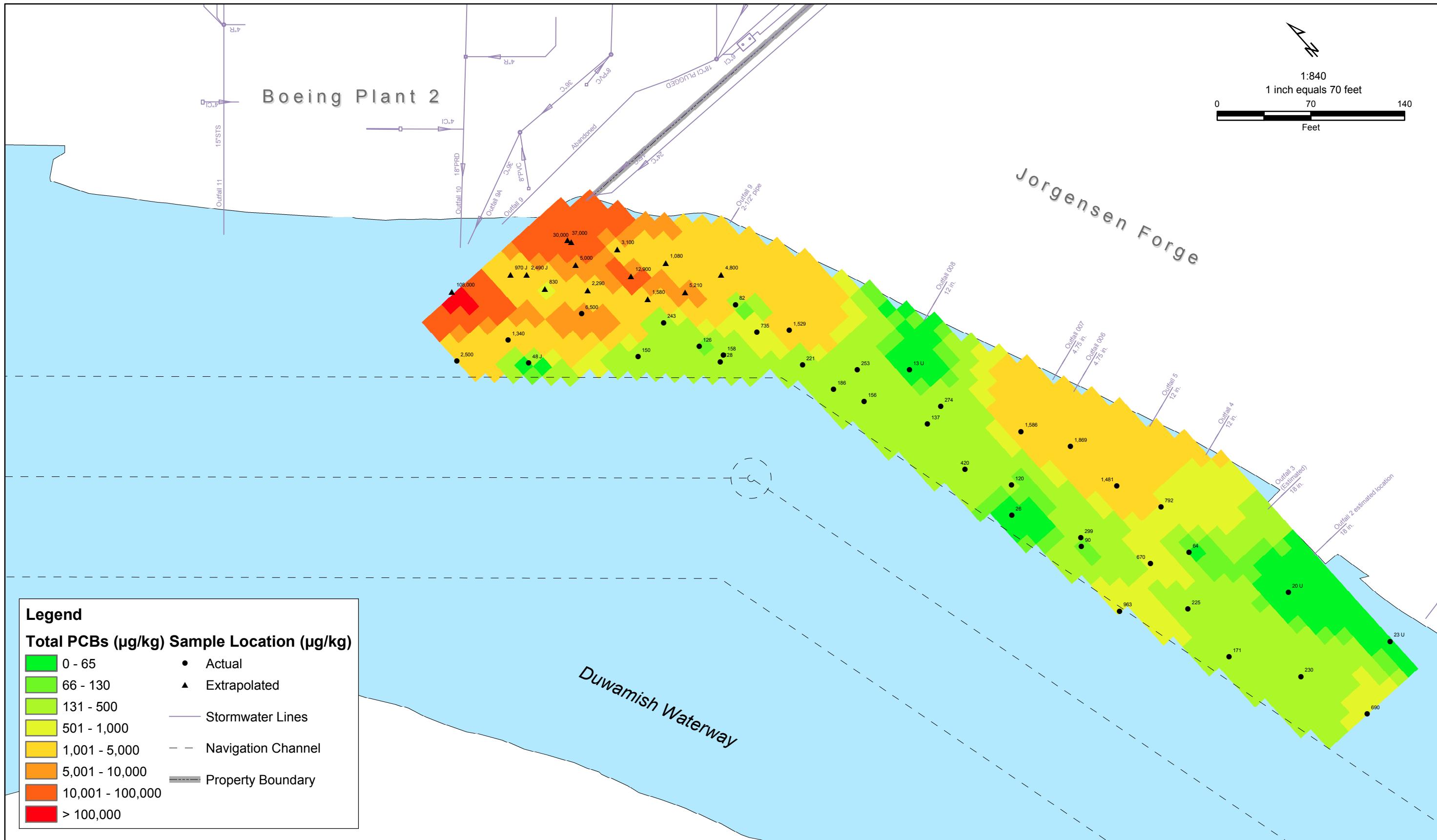


## **Technical Workgroup**

## **South Boeing Plant 2 and Jorgensen Forge Waterfront Seattle, Washington**

## Interpolated Concentration of Total PCBs in Sediment Surface (0-10 cm) Interval

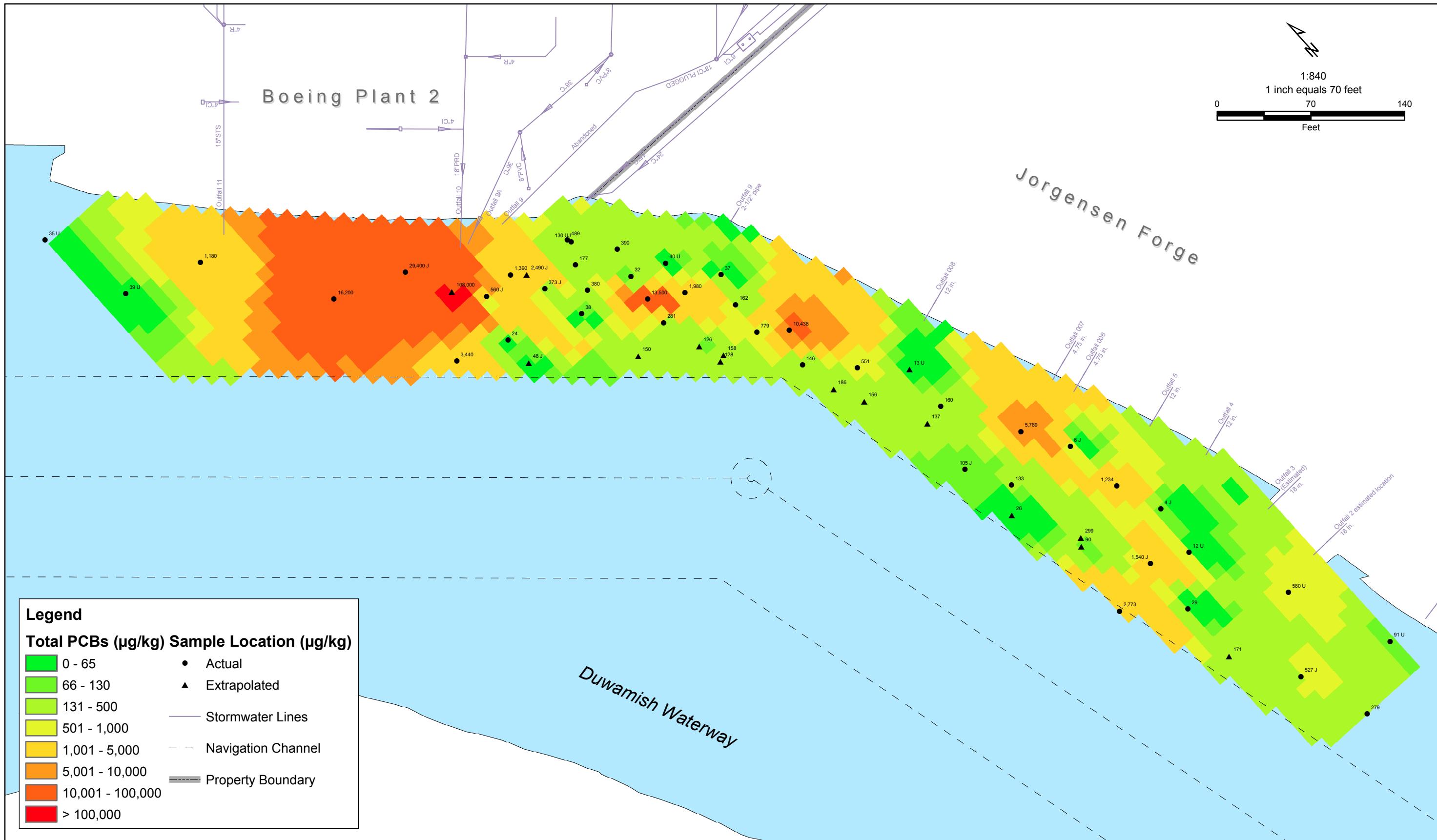


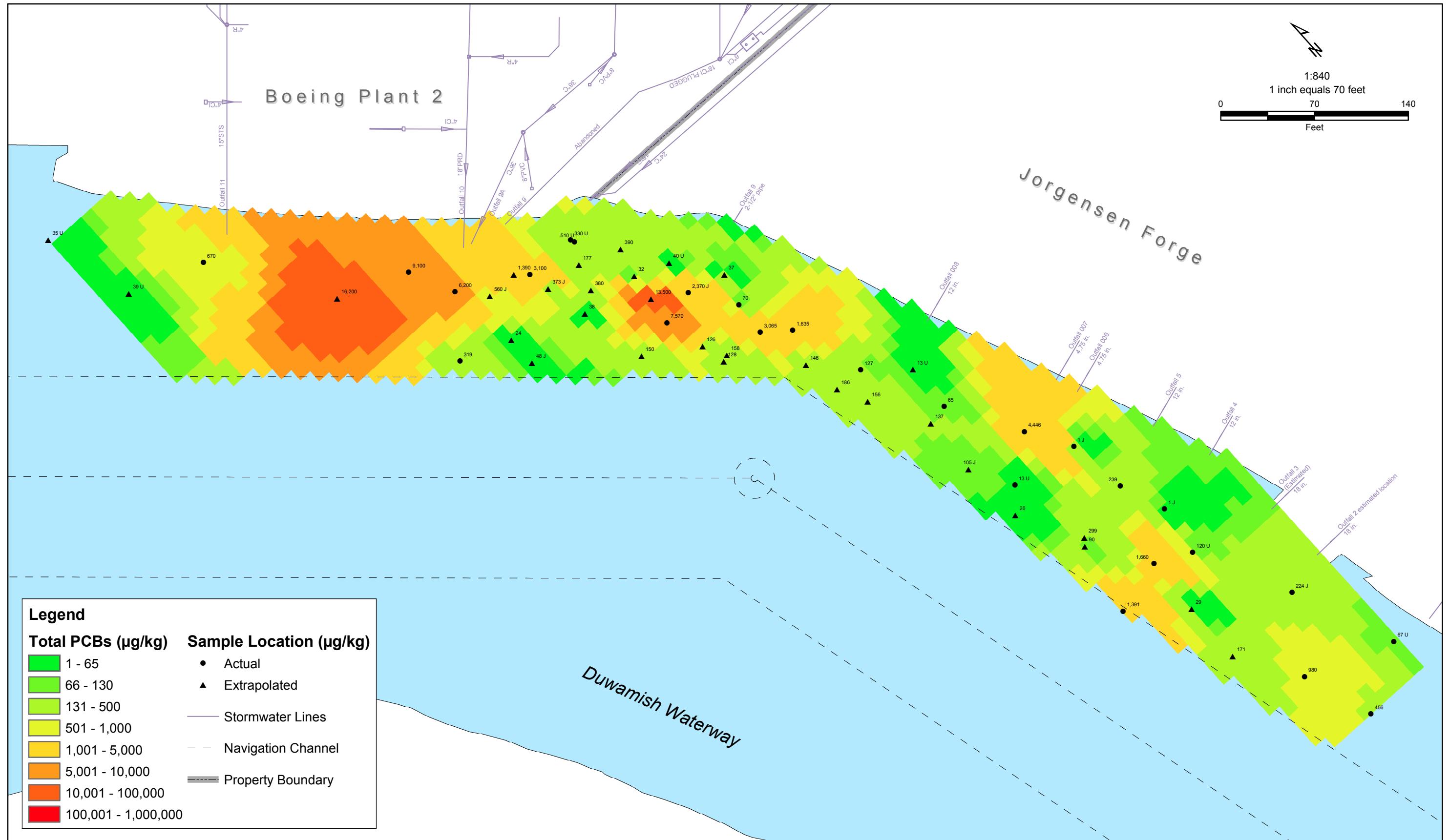


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South Boeing Plant 2 and Jorgensen Forge Waterfront  
Seattle, Washington

Interpolated Concentration of Total PCBs in Sediment  
1 - 2 ft Interval

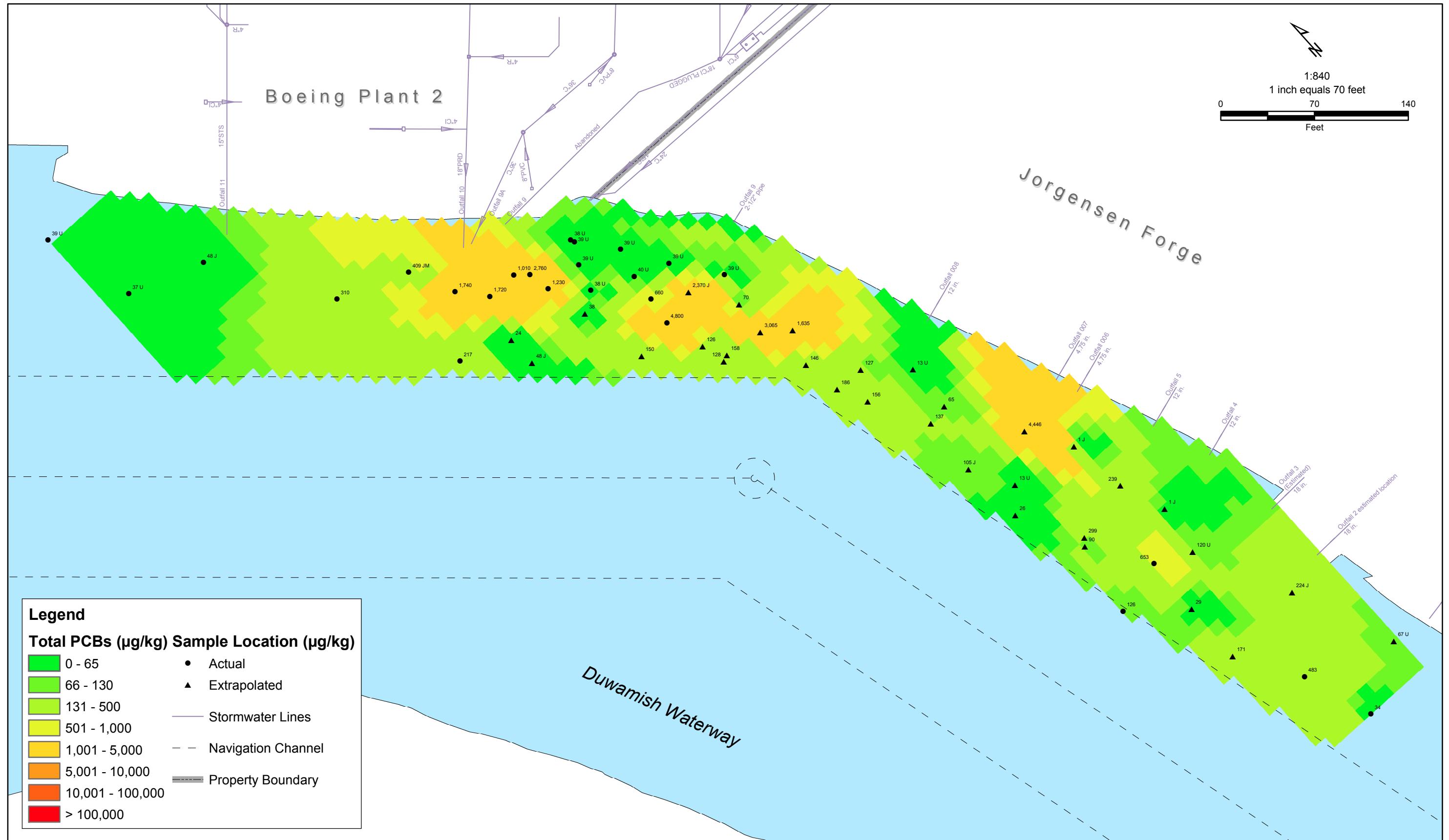




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## **South Boeing Plant 2 and Jorgensen Forge Waterfront Seattle, Washington**

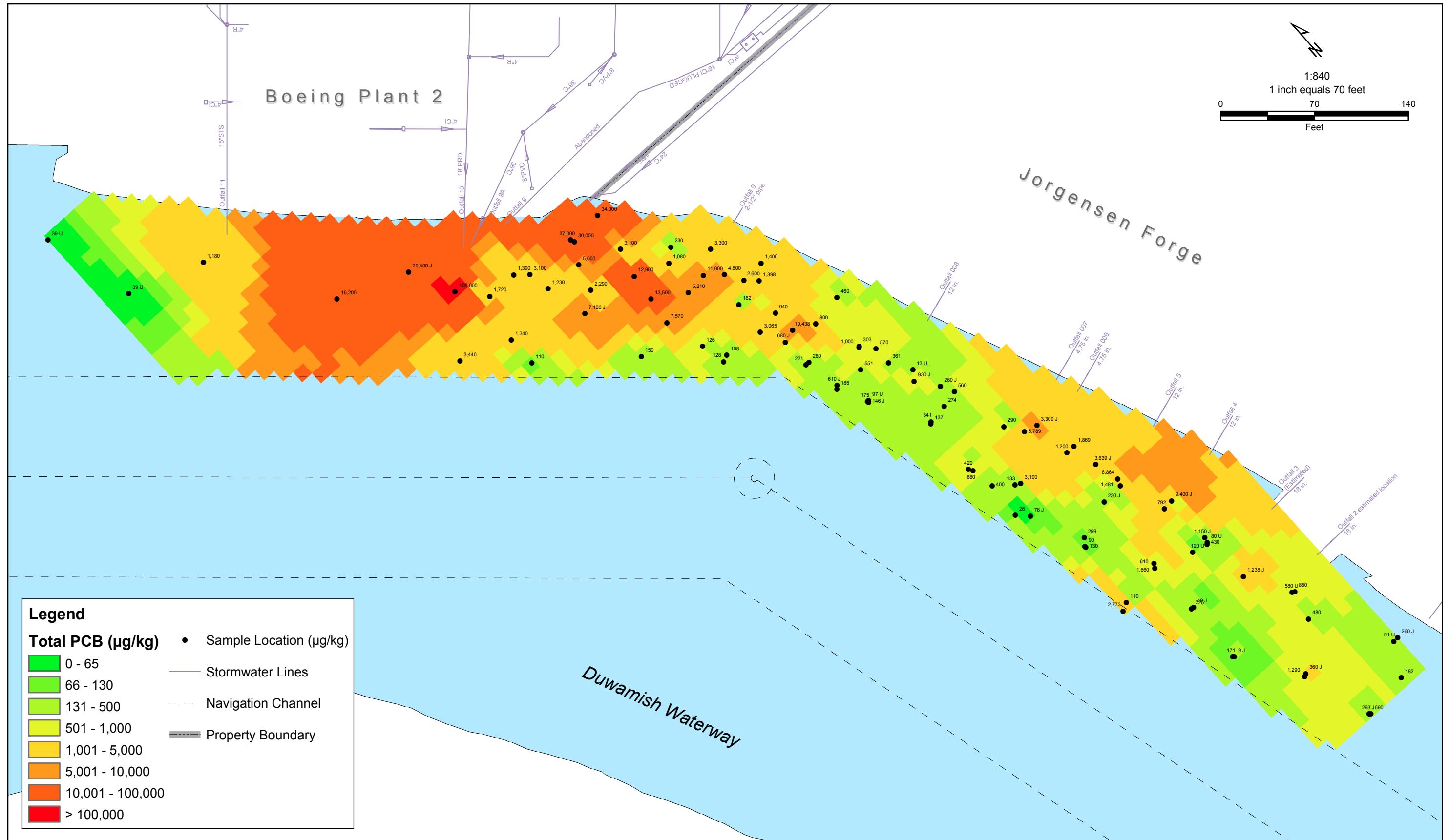
## **Interpolated Concentration of Total PCBs in Sediment 3 - 4 ft Interval**



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## **South Boeing Plant 2 and Jorgensen Forge Waterfront Seattle, Washington**

## Interpolated Concentration of Total PCBs in Sediment 4 - 5 ft Interval

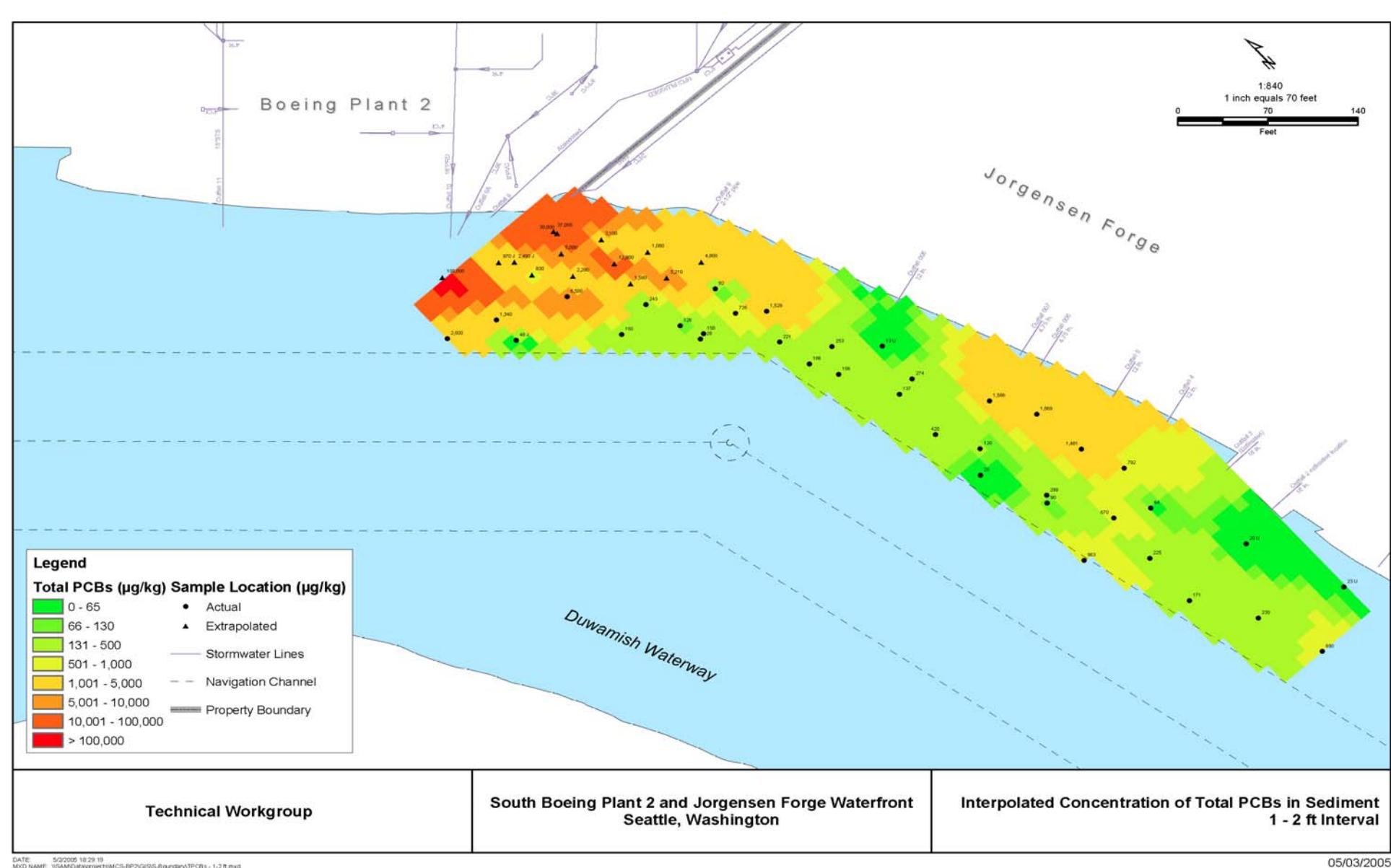
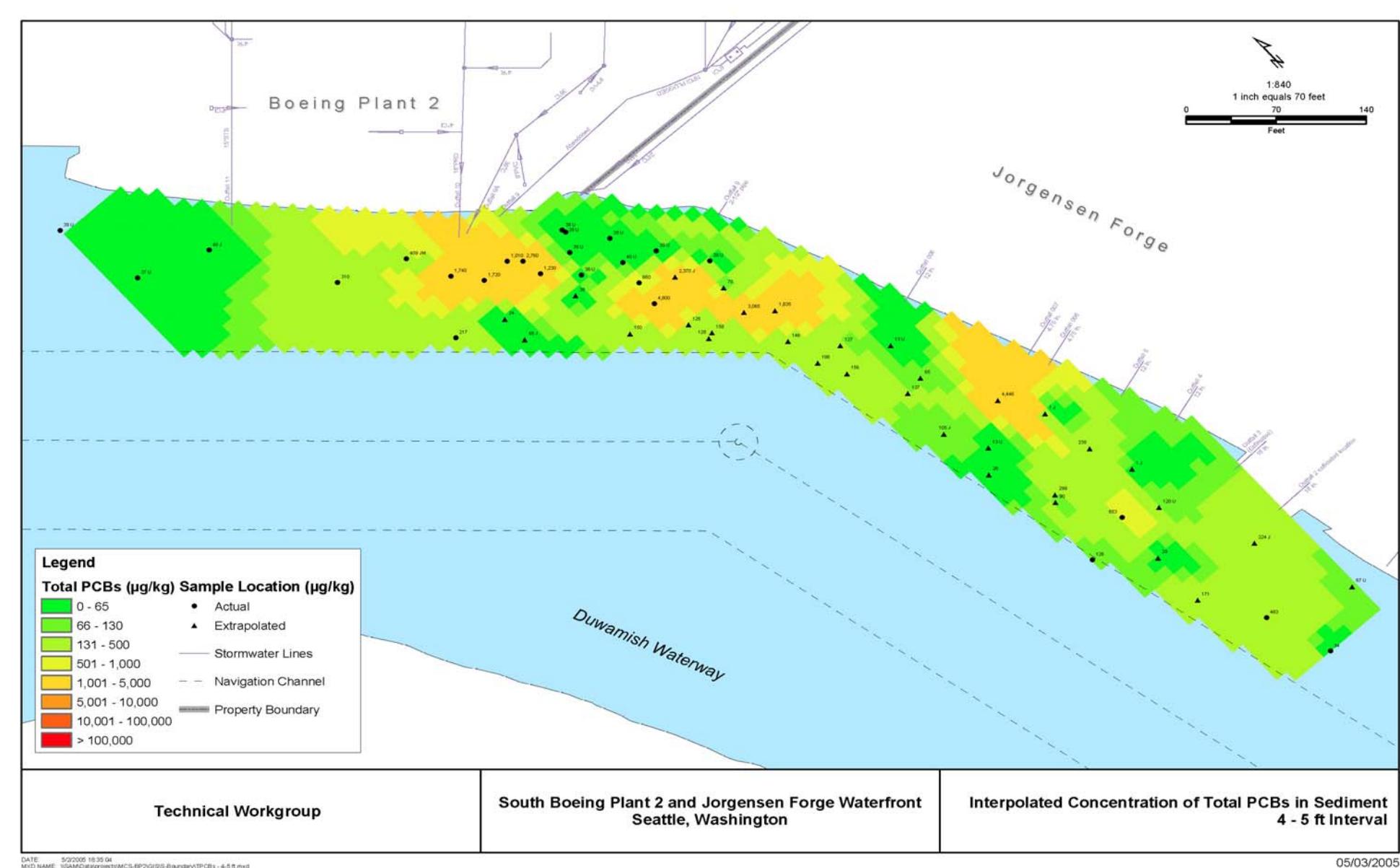
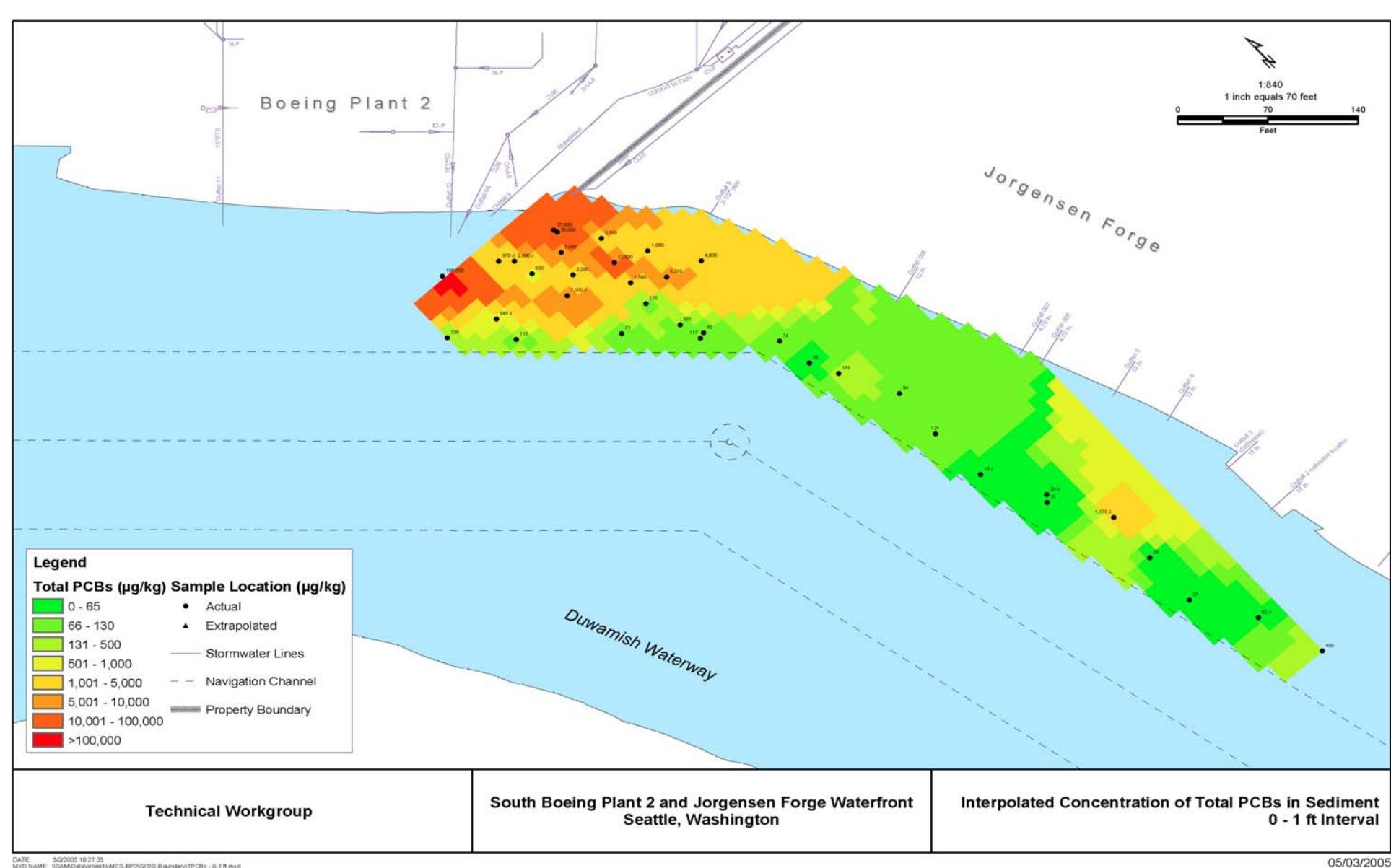
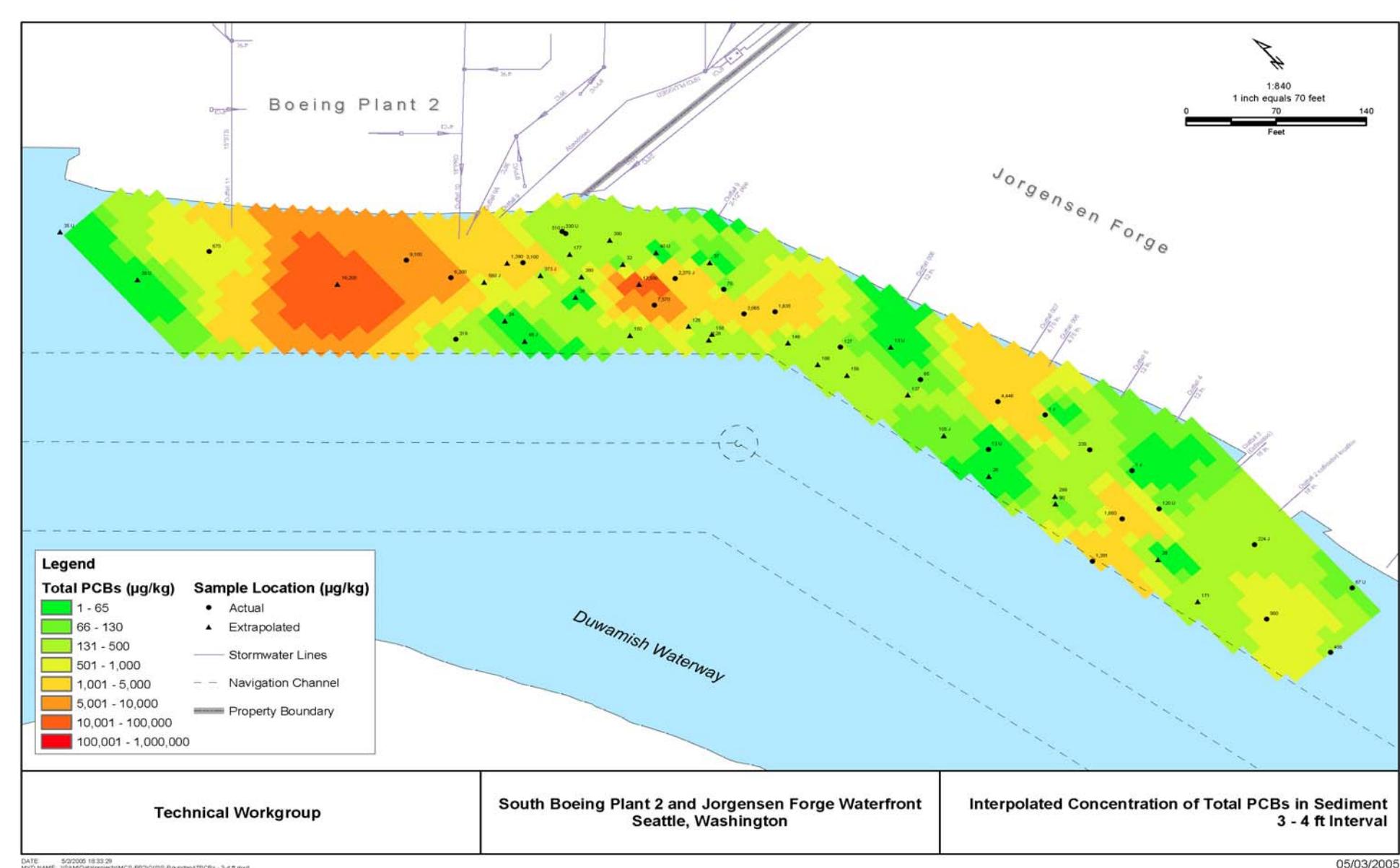
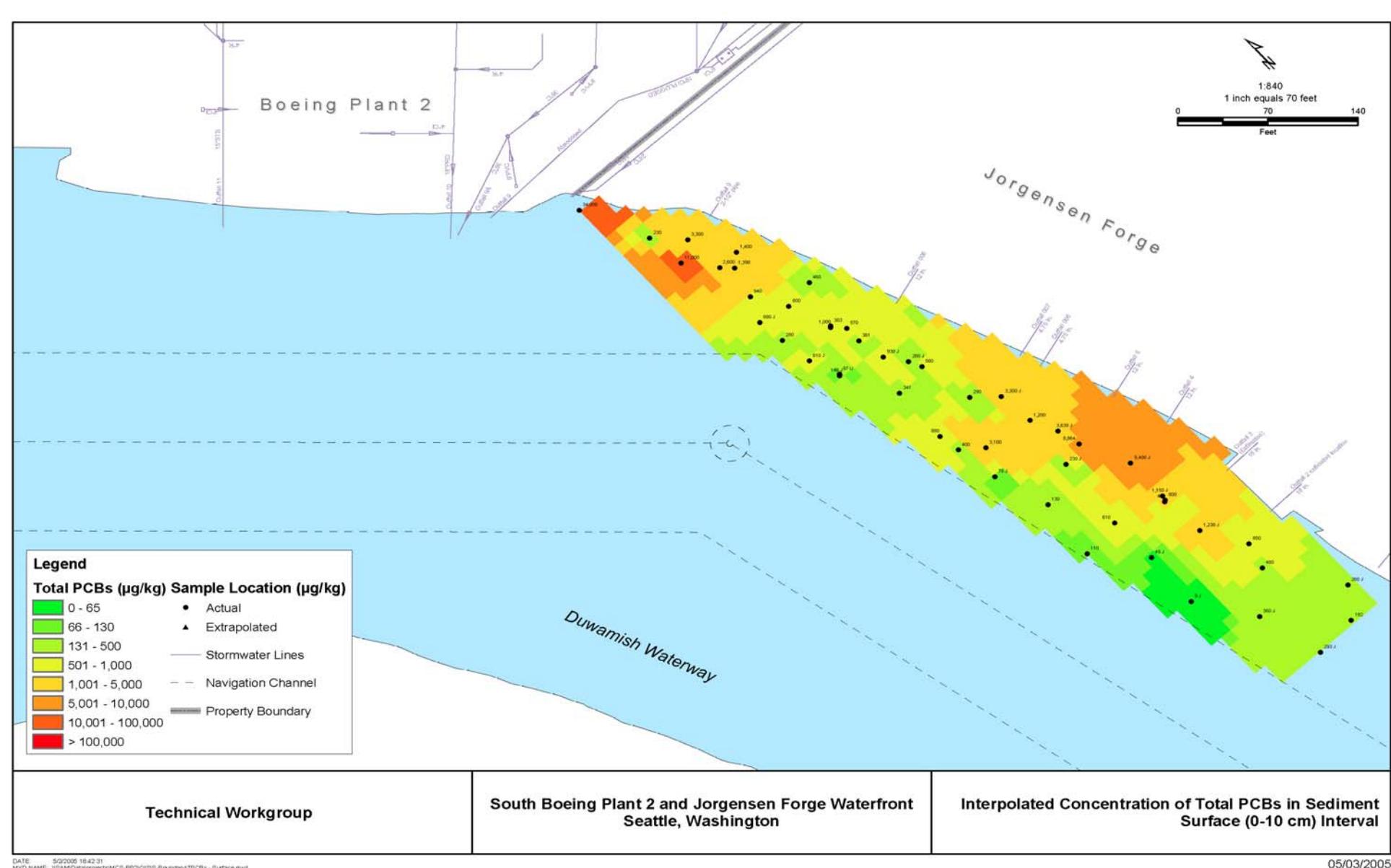
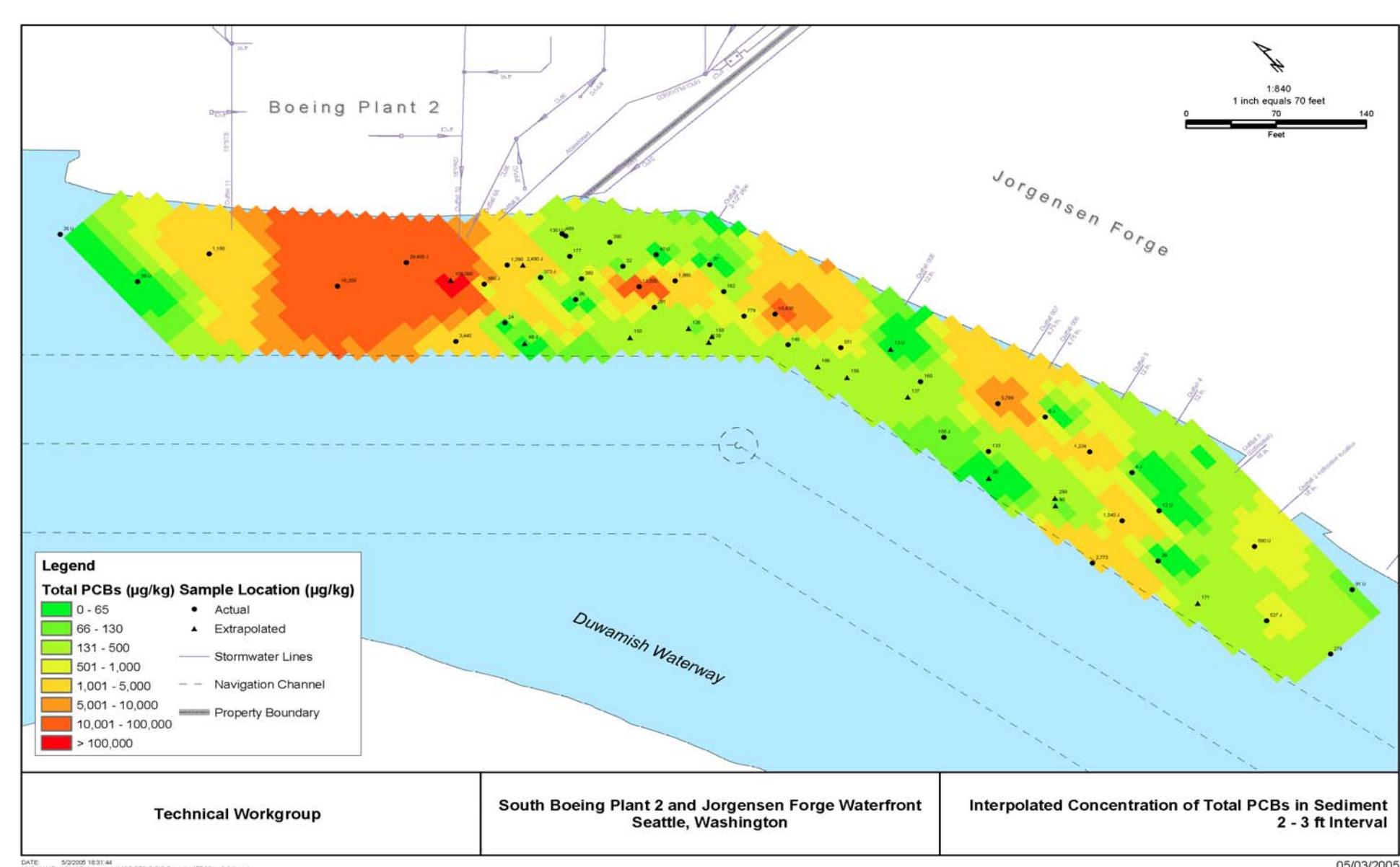
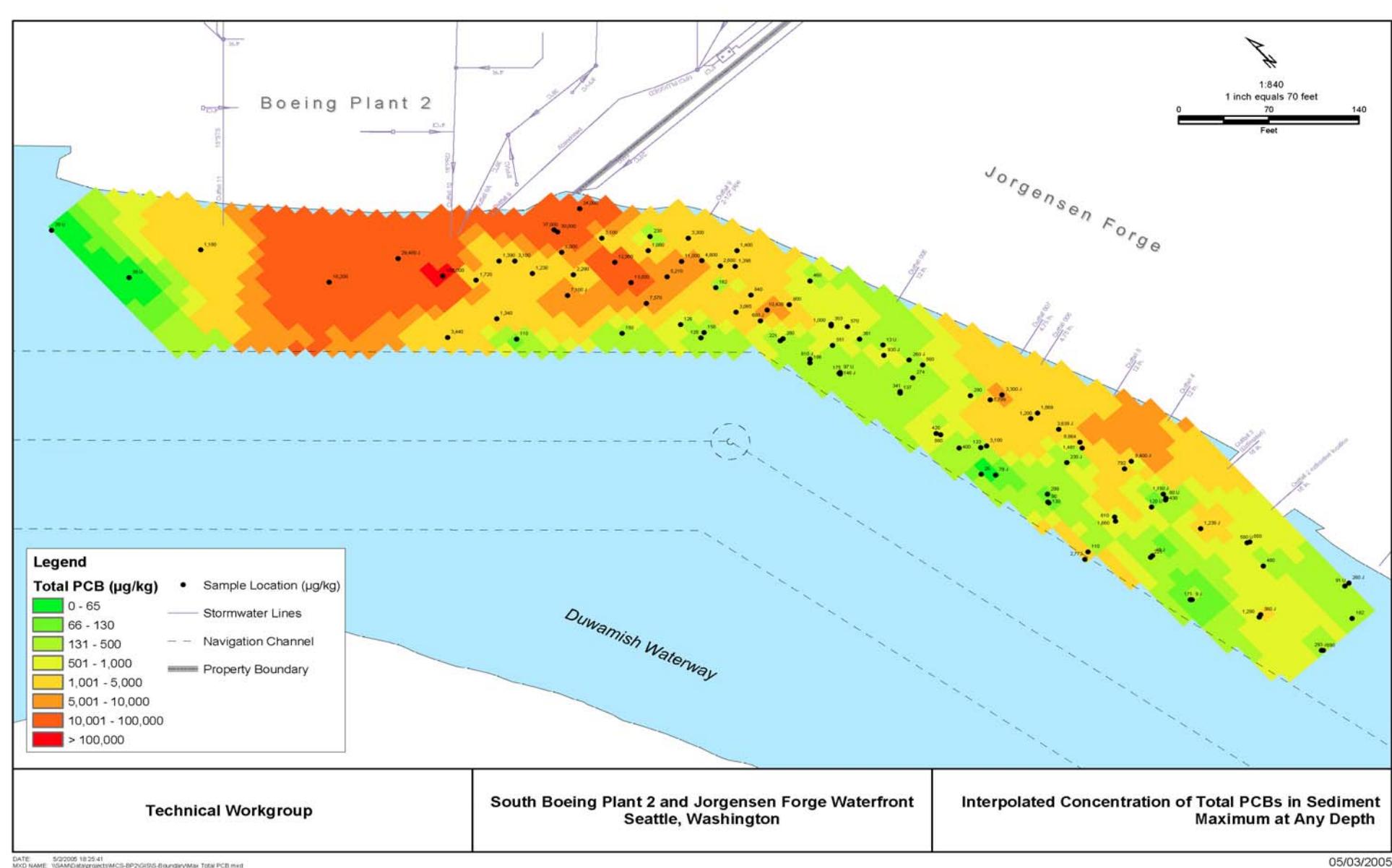


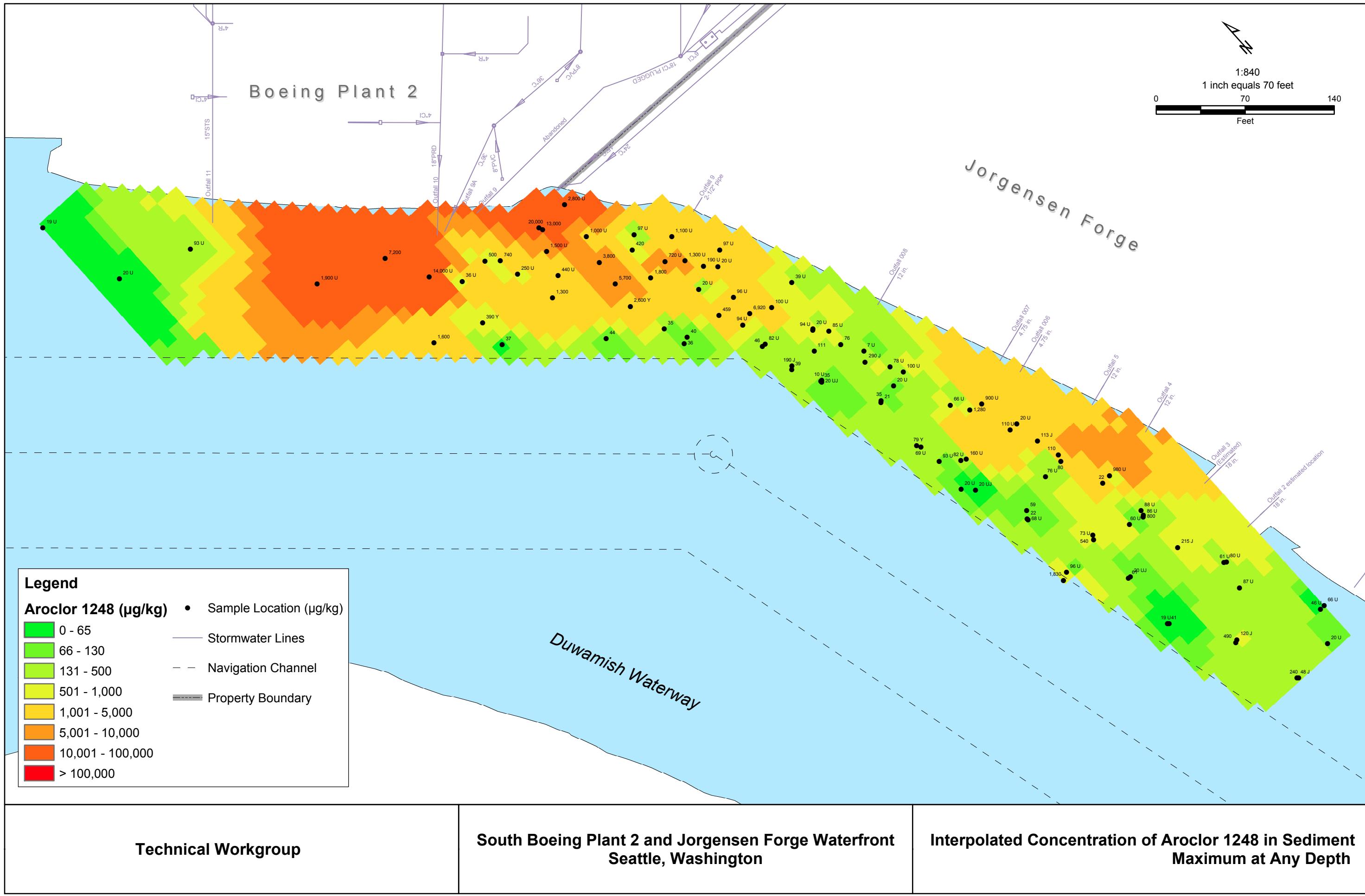
## Technical Workgroup

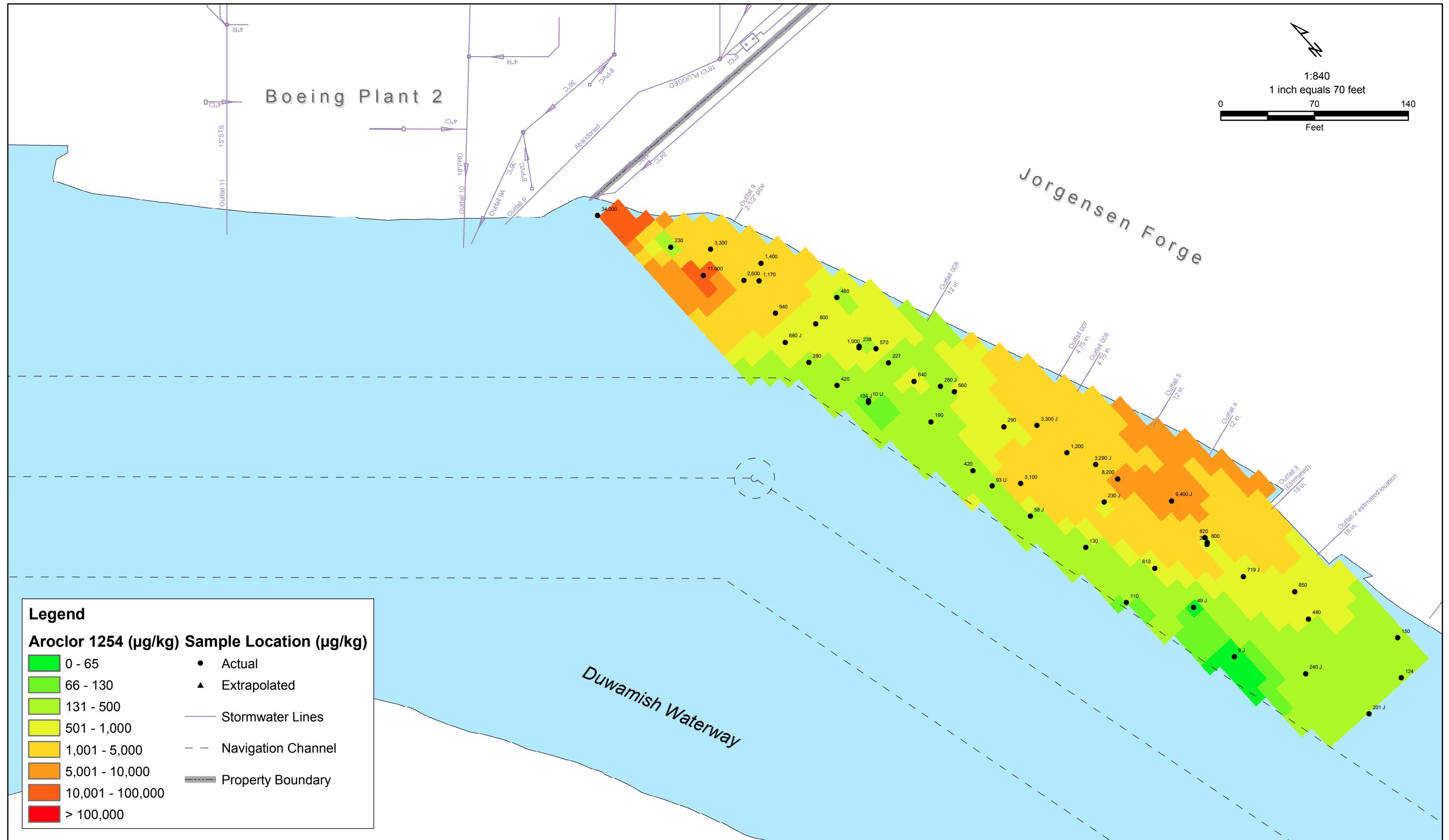
## **South Boeing Plant 2 and Jorgensen Forge Waterfront Seattle, Washington**

## Interpolated Concentration of Total PCBs in Sediment Maximum at Any Depth

# Concentration of Total PCBs



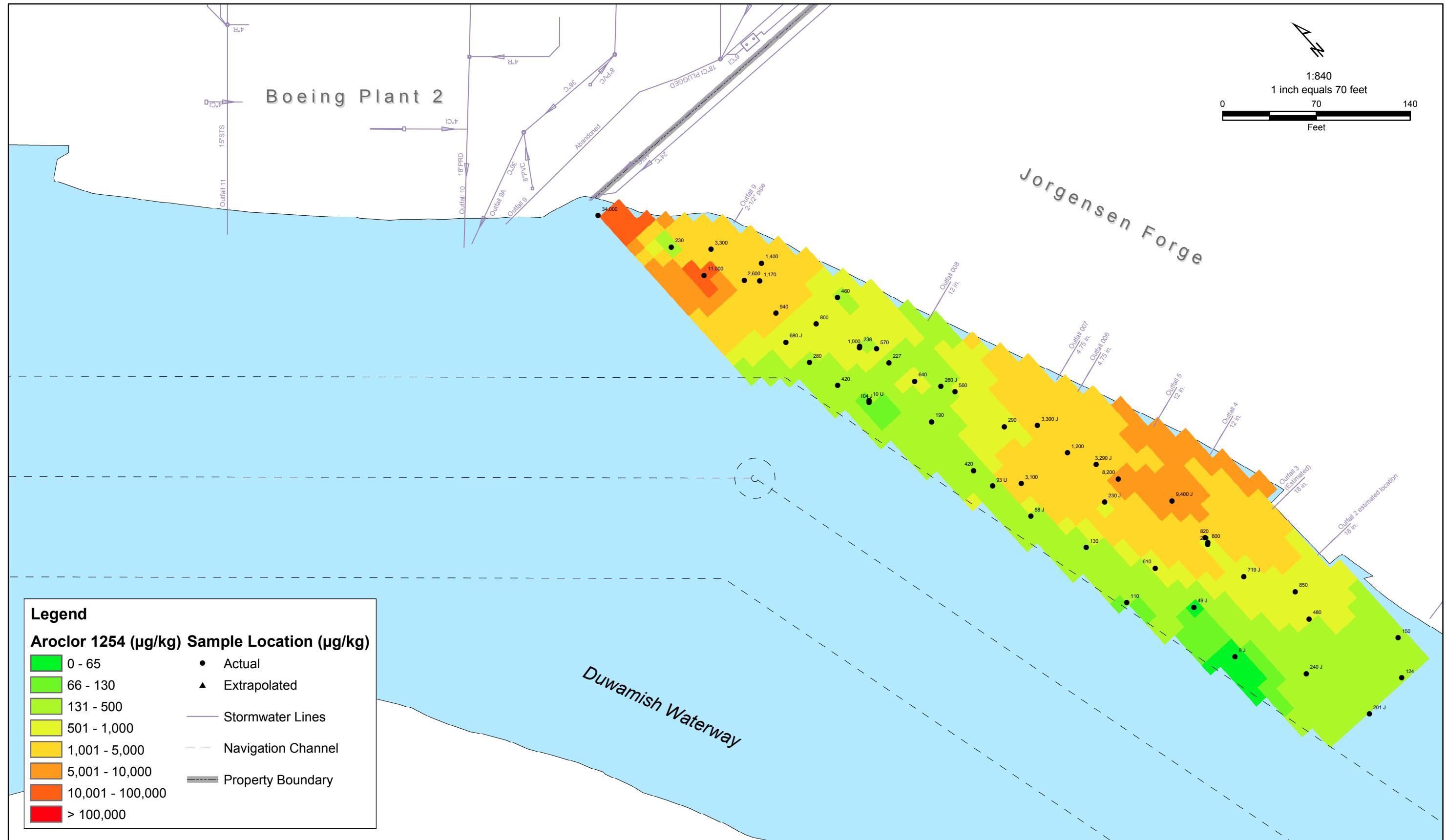


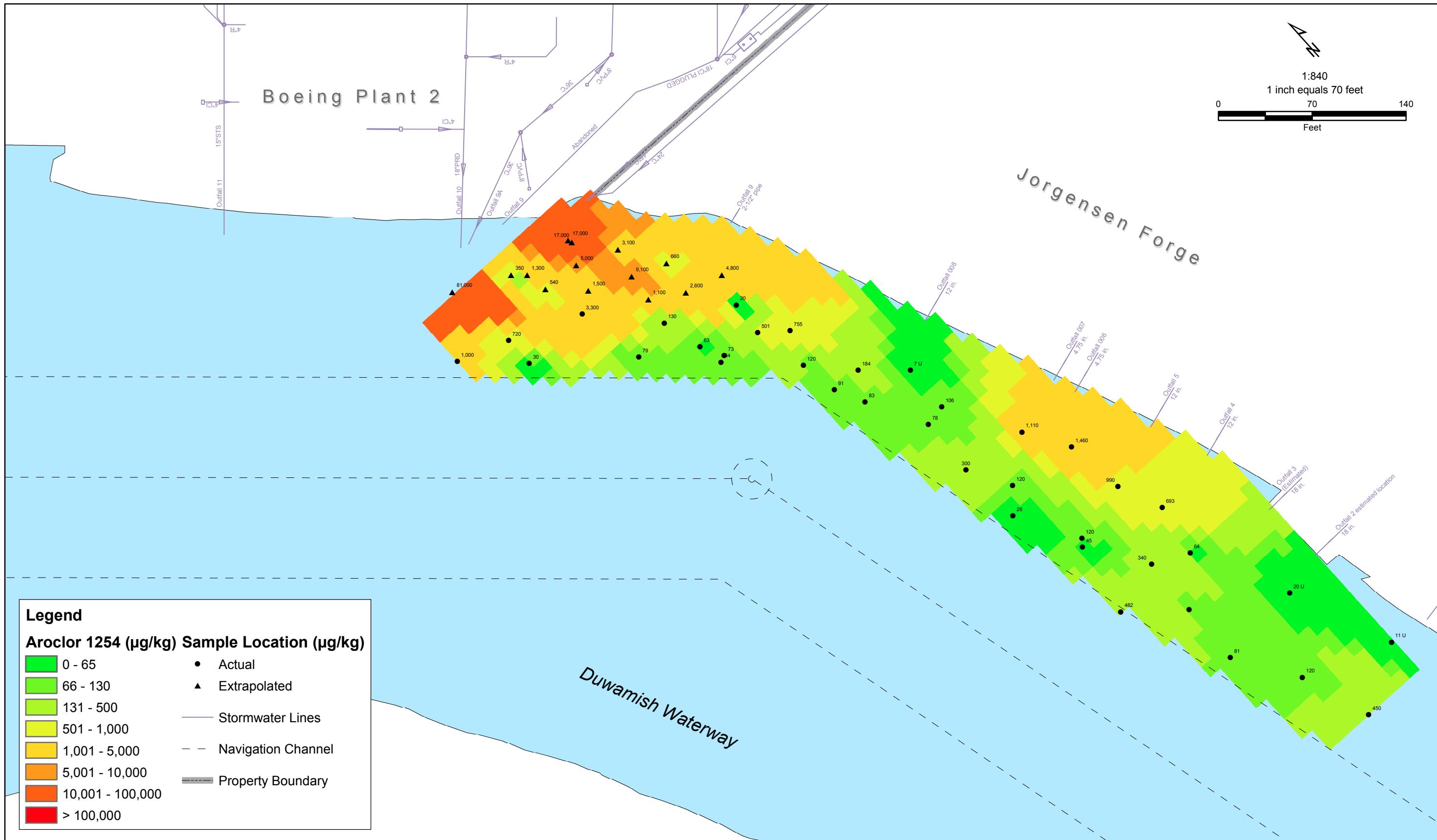


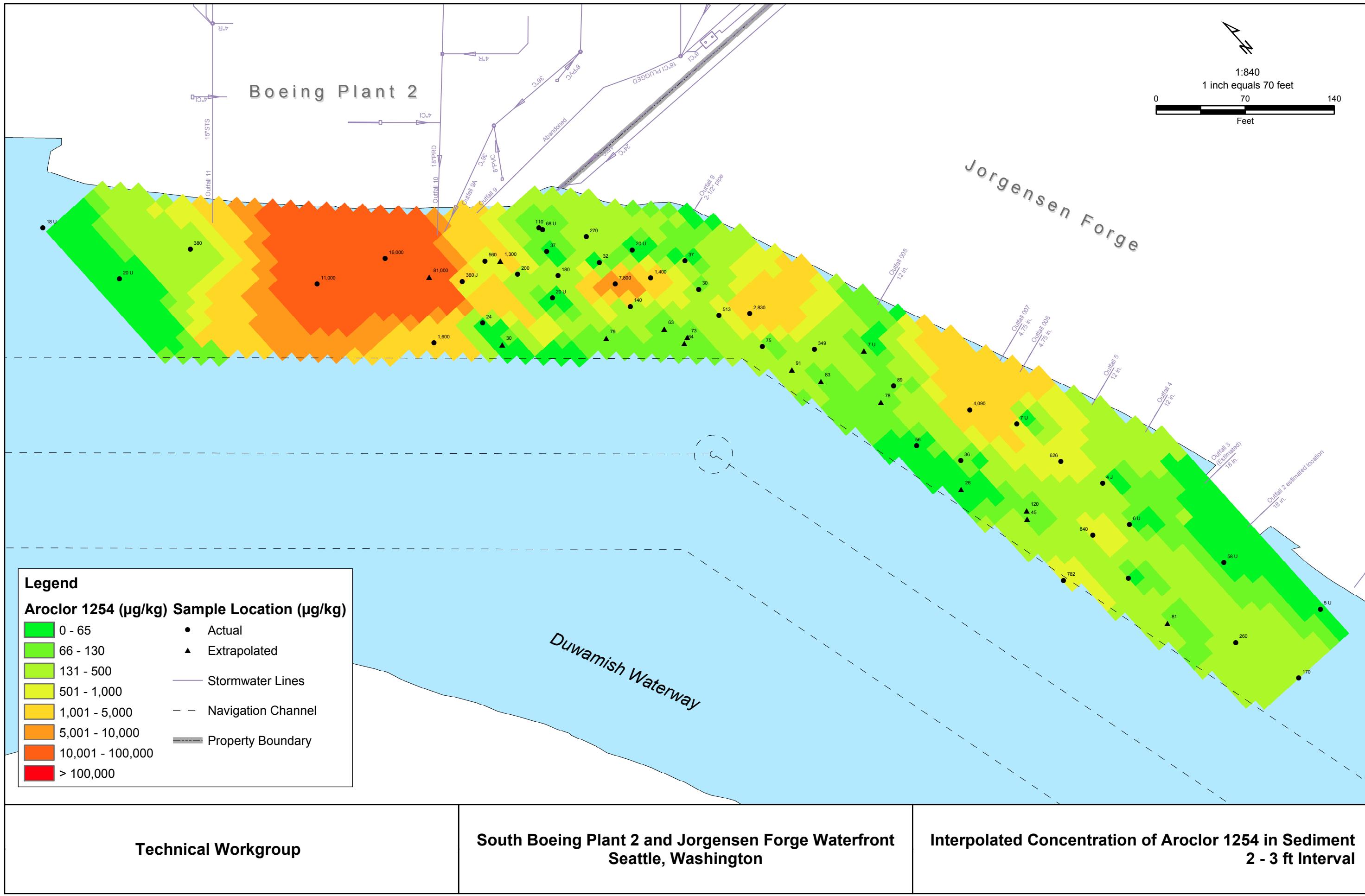
## **Technical Workgroup**

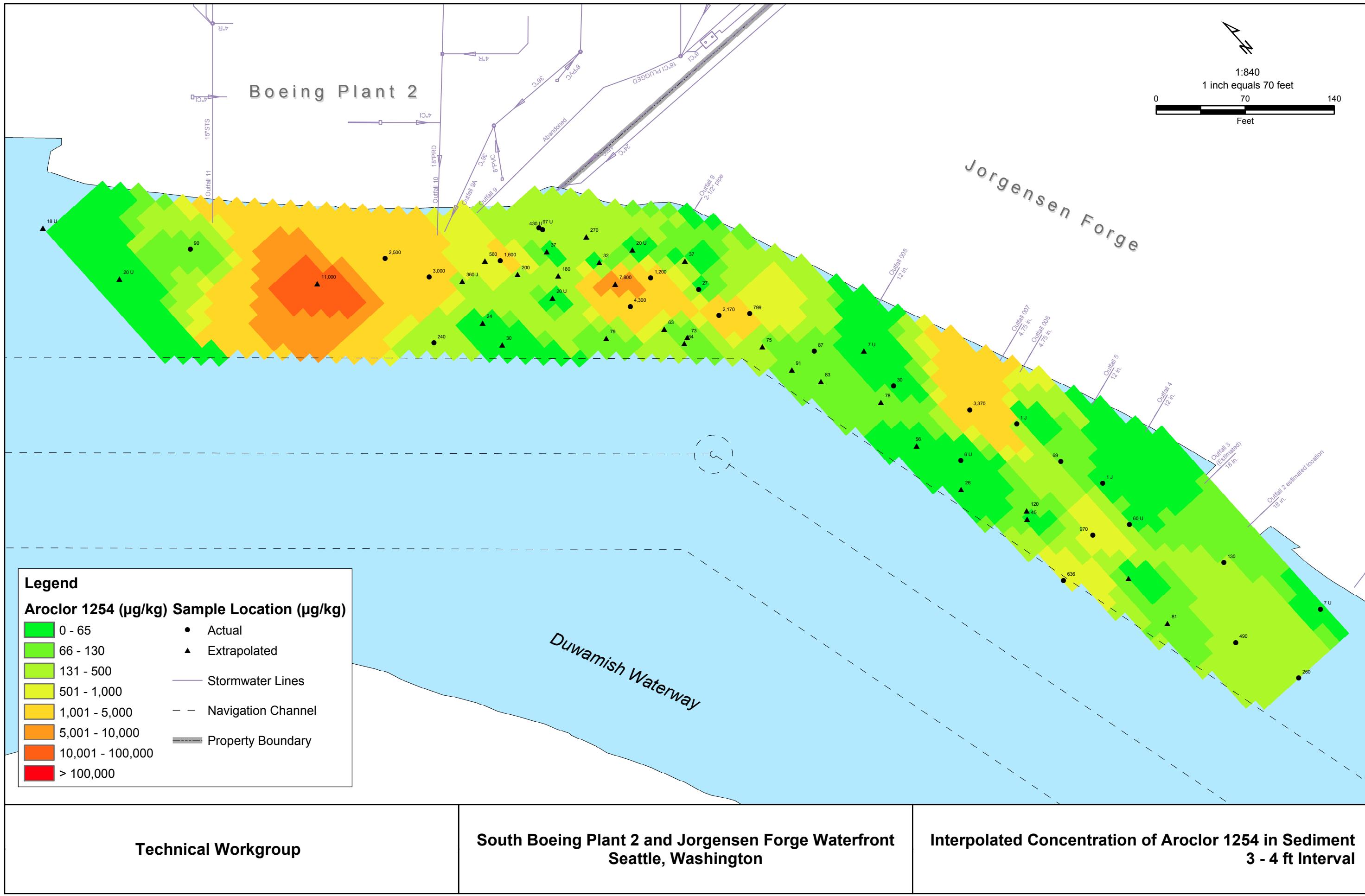
## **South Boeing Plant 2 and Jorgensen Forge Waterfront Seattle, Washington**

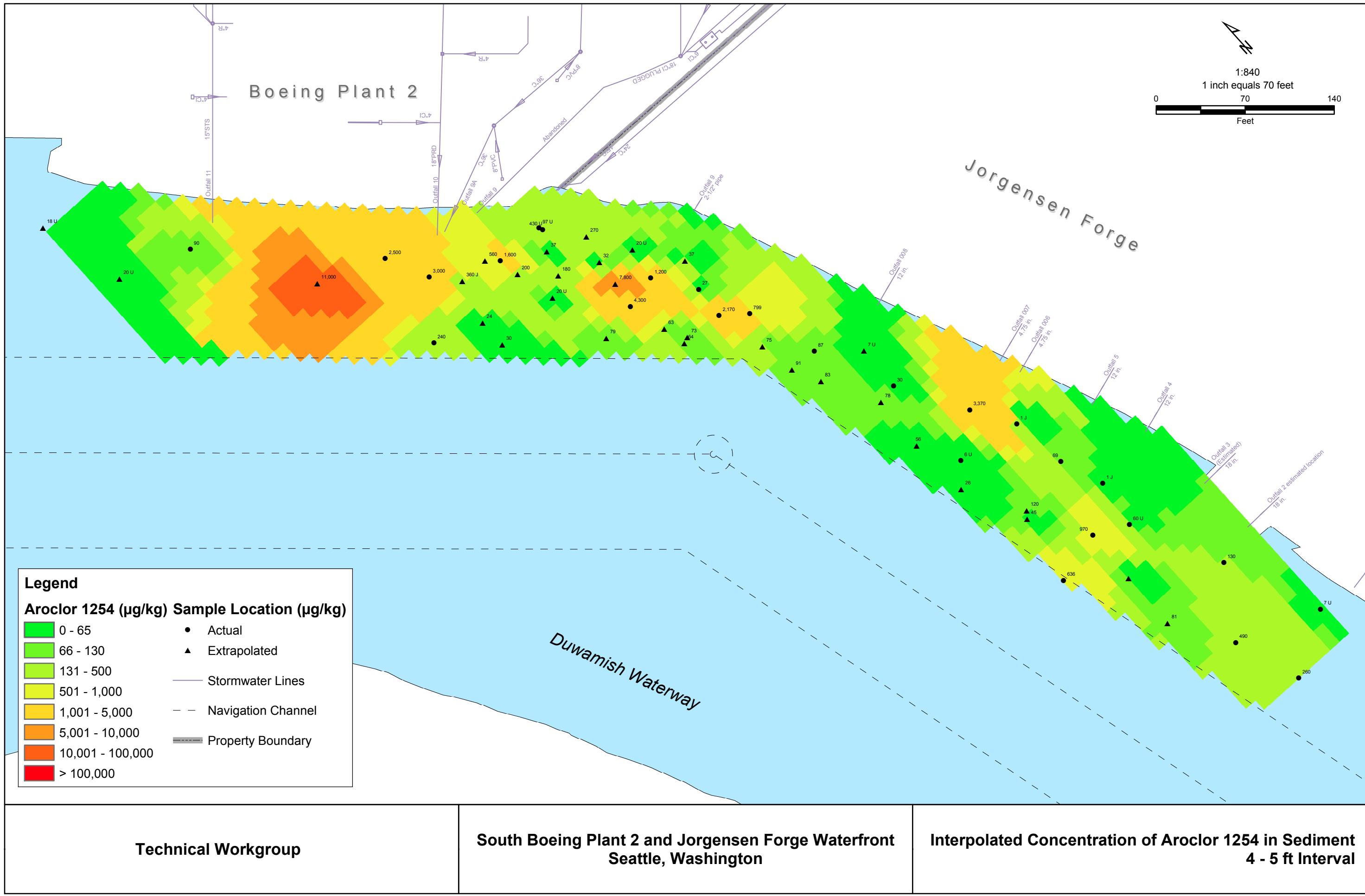
## Interpolated Concentration of Aroclor 1254 in Sediment Surface (0-10 cm) Interval

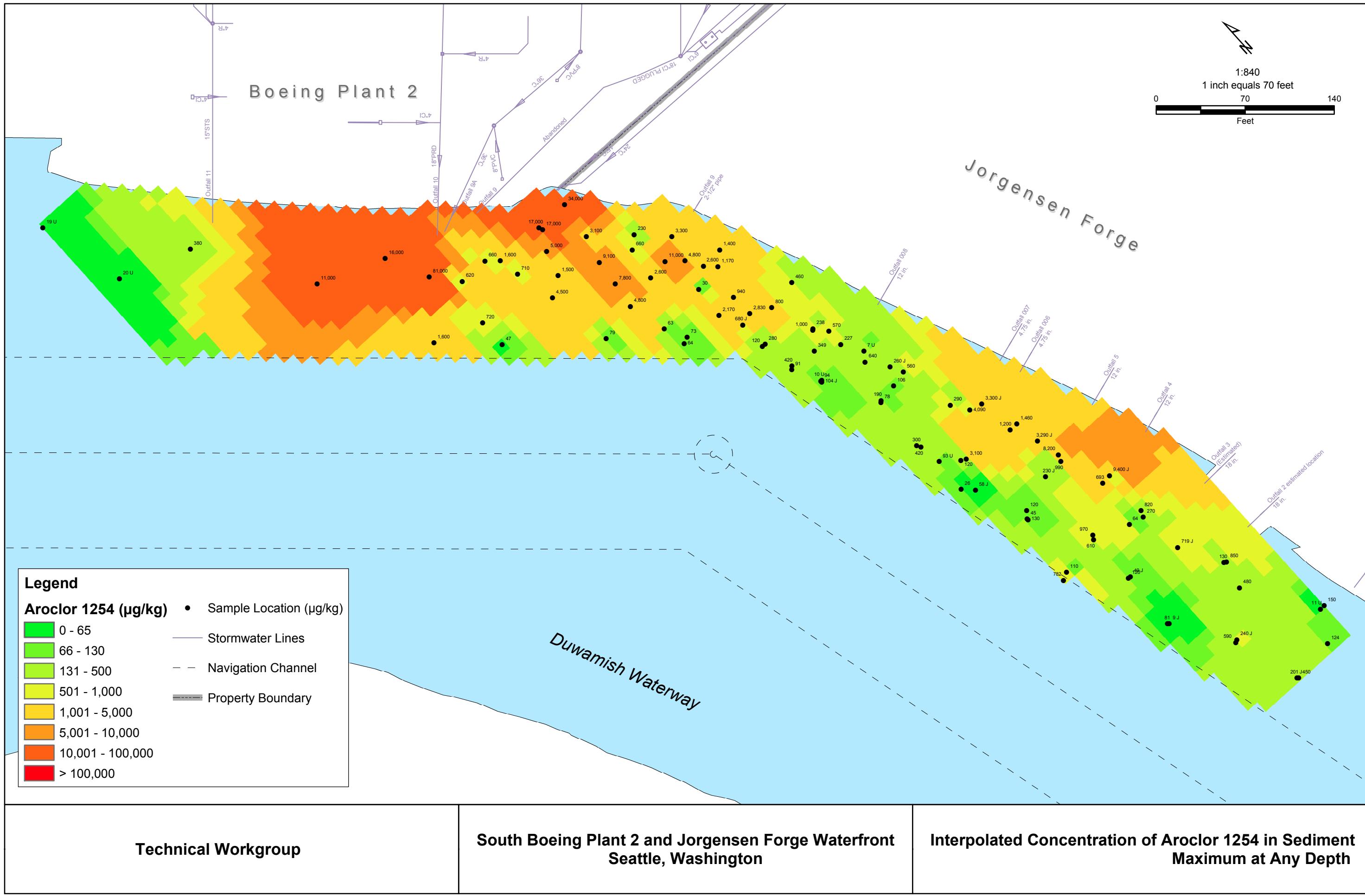


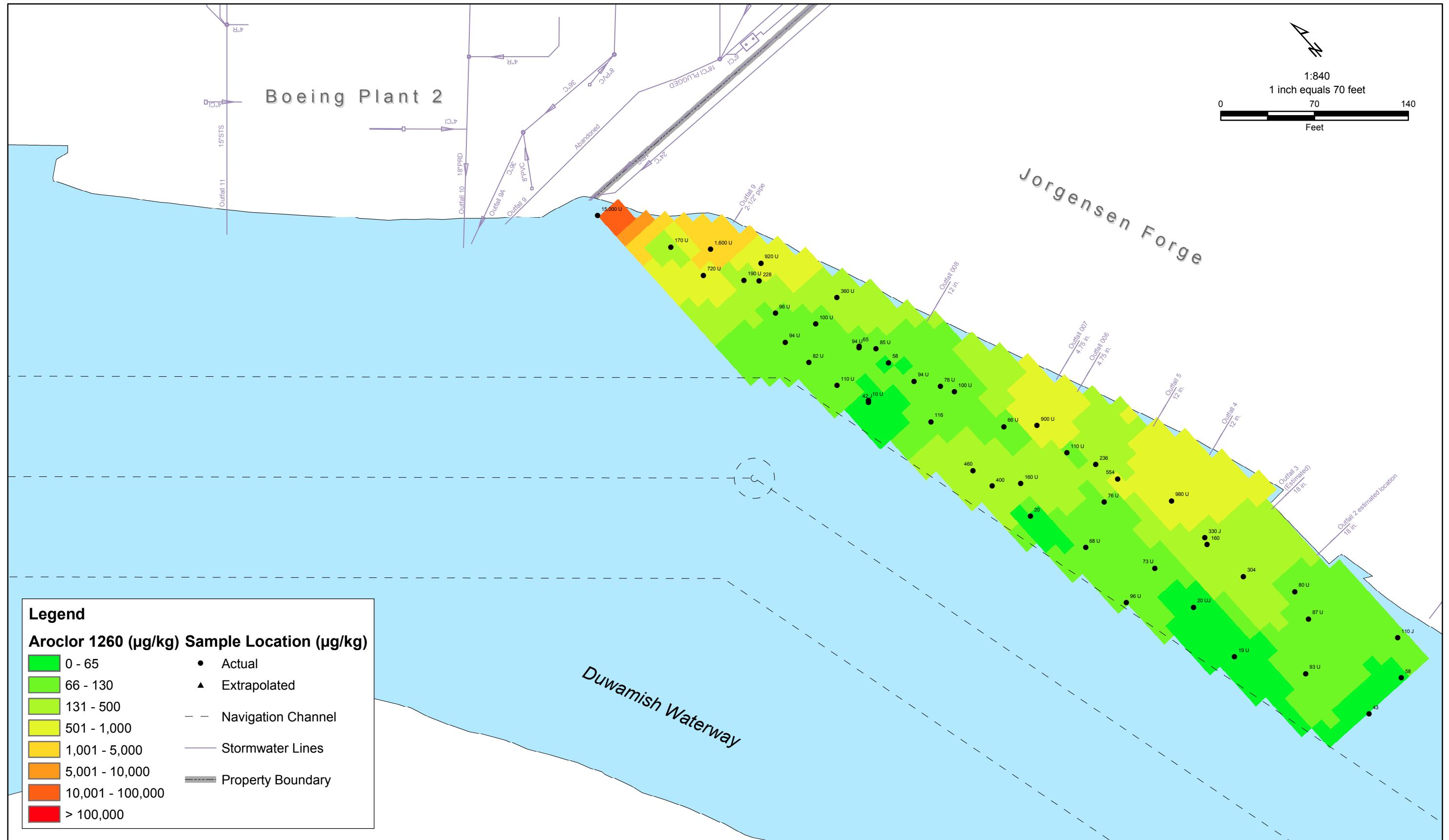








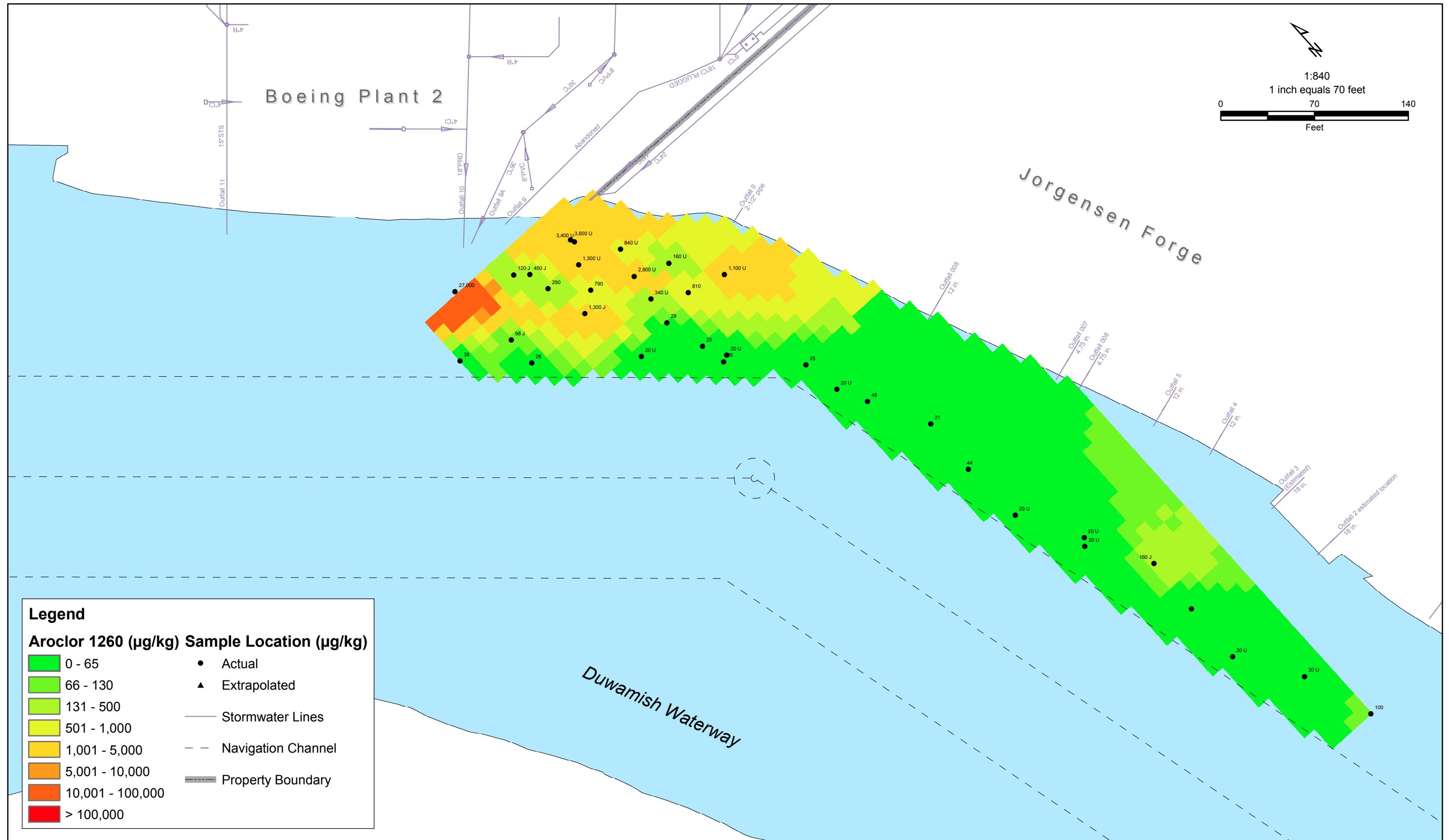




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## **South Boeing Plant 2 and Jorgensen Forge Waterfront Seattle, Washington**

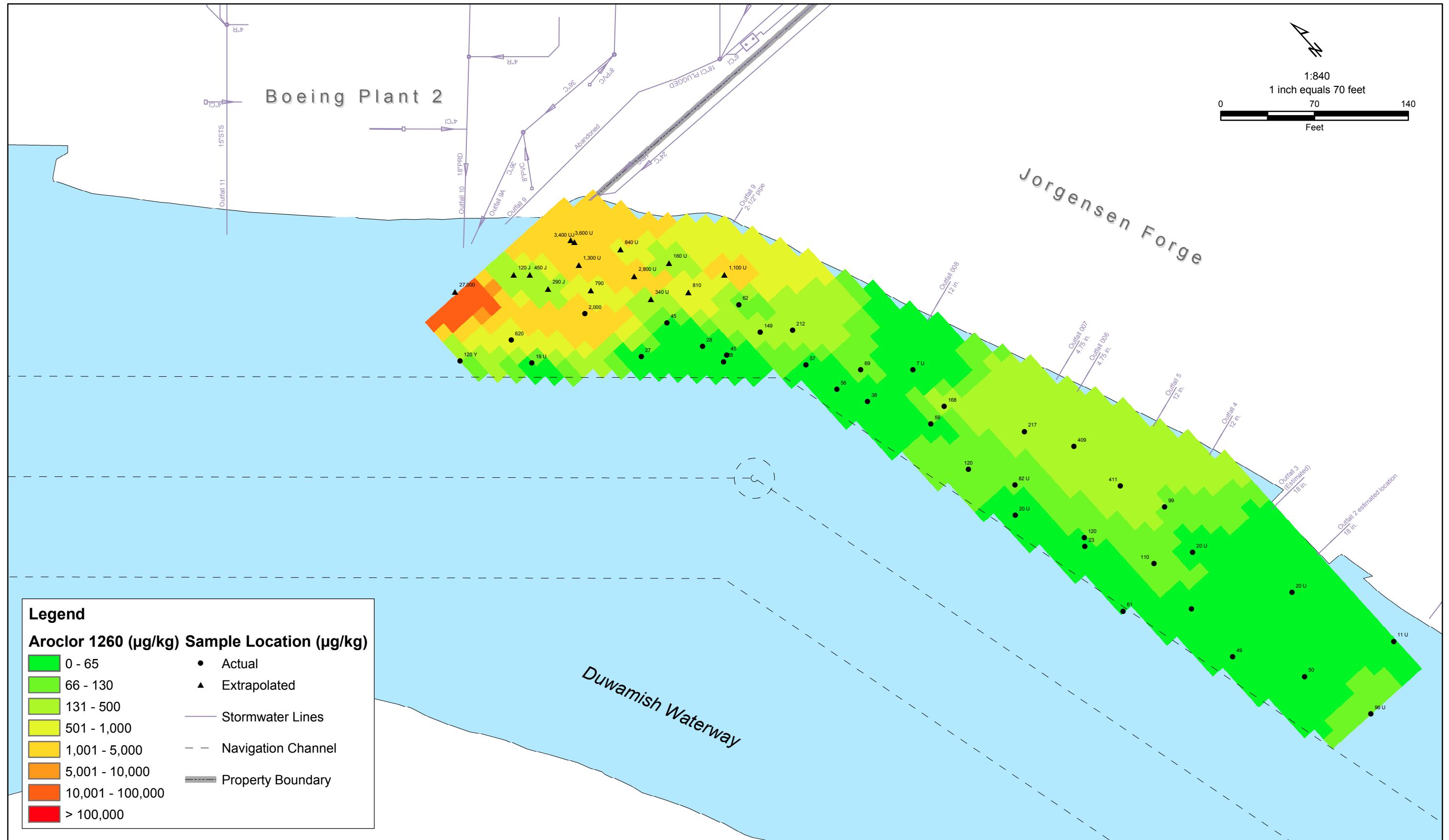
## Interpolated Concentration of Aroclor 1260 in Sediment Surface (0-10 cm) Interval



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## **South Boeing Plant 2 and Jorgensen Forge Waterfront Seattle, Washington**

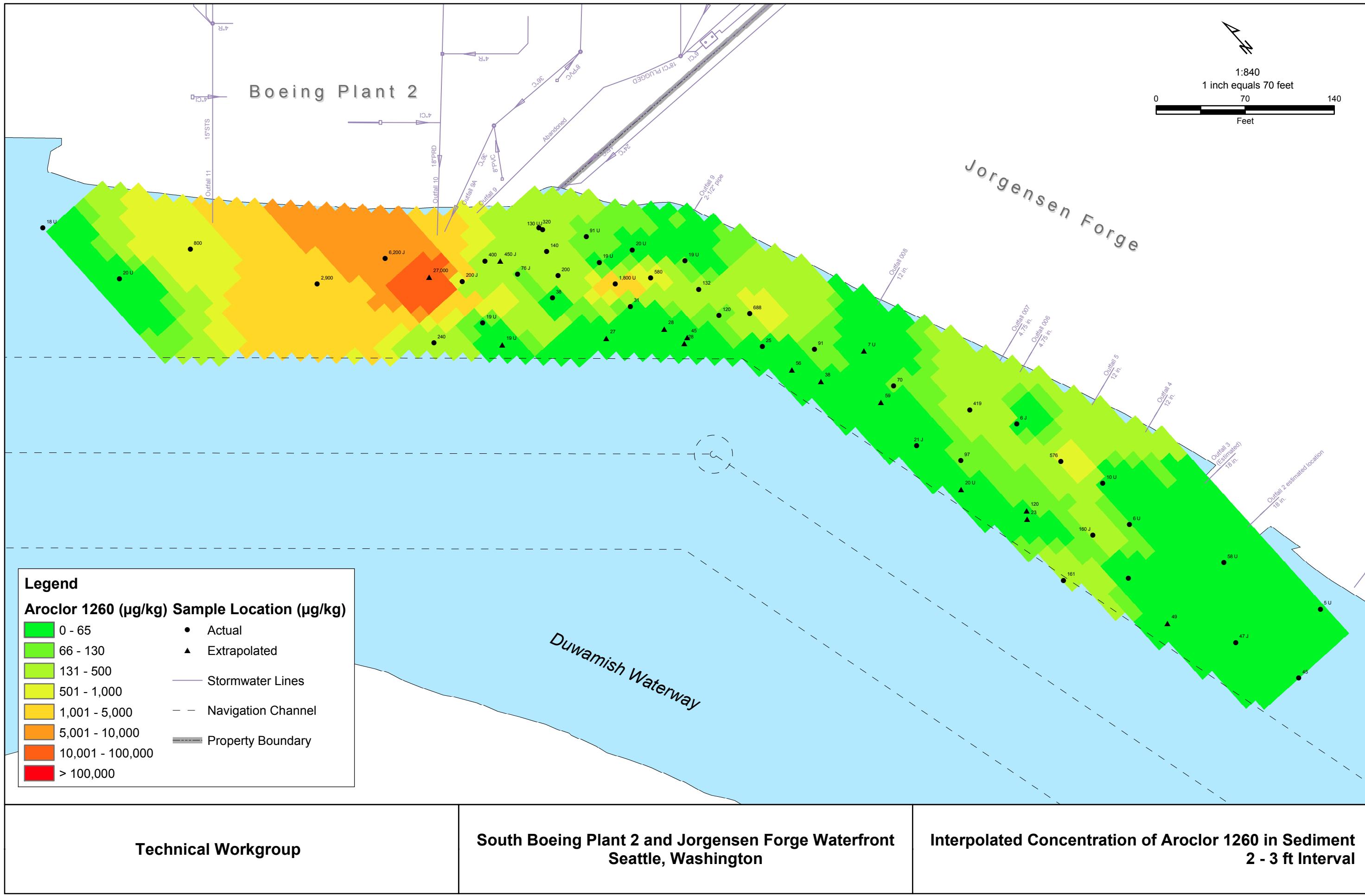
## Interpolated Concentration of Aroclor 1260 in Sediment 0 - 1 ft Interval

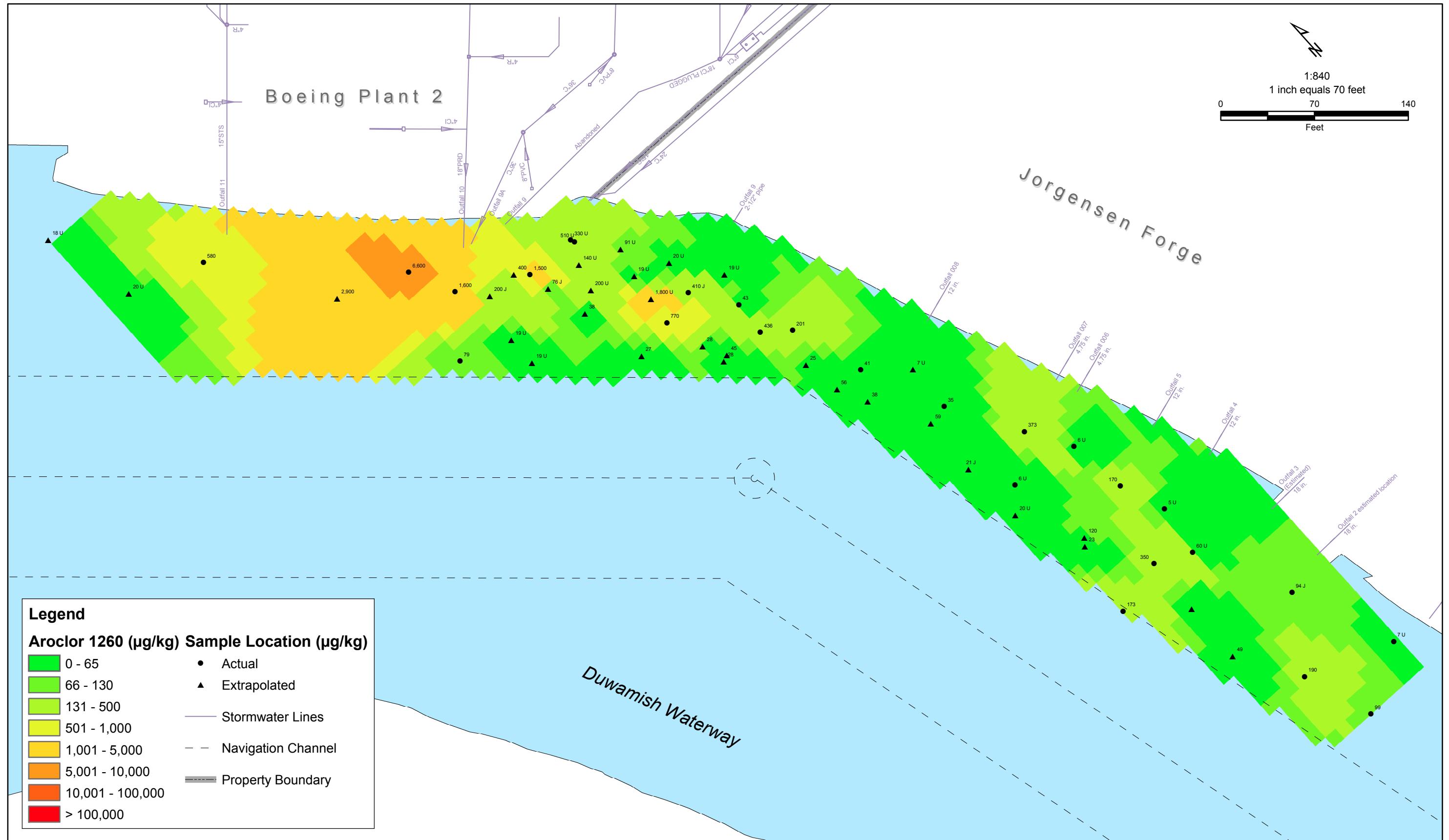


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## **South Boeing Plant 2 and Jorgensen Forge Waterfront Seattle, Washington**

## **Interpolated Concentration of Aroclor 1260 in Sediment 1 - 2 ft Interval**

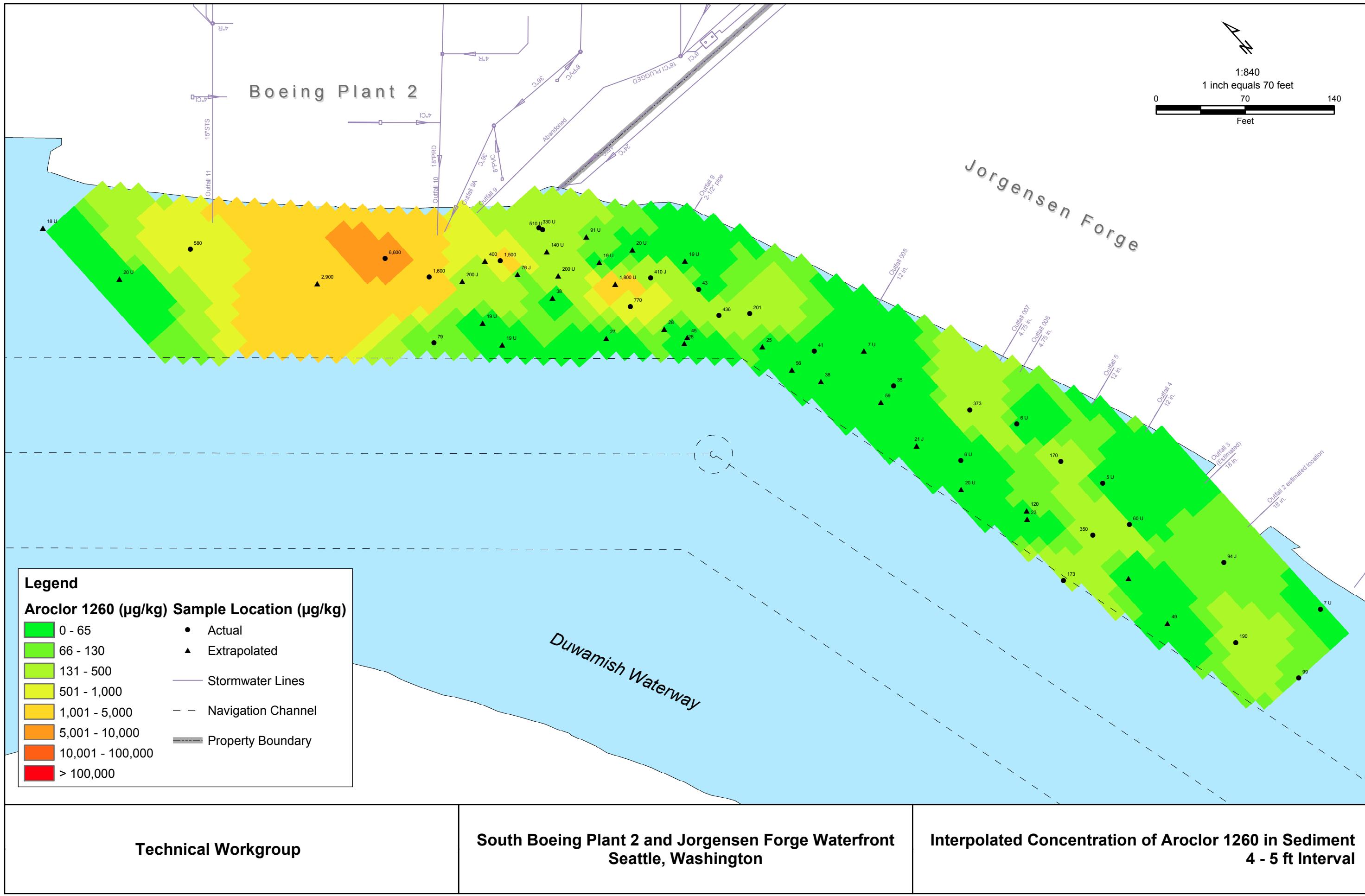


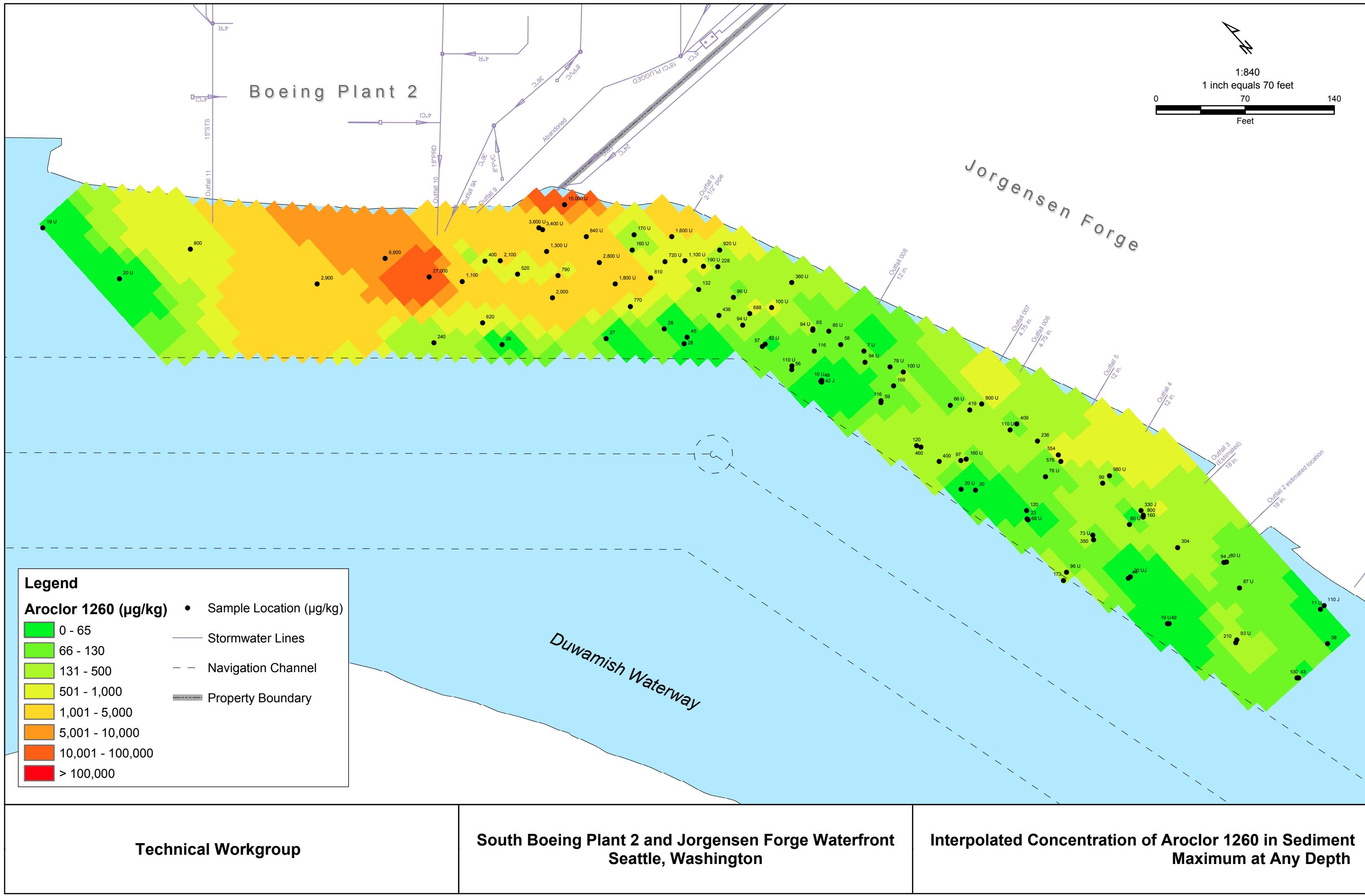


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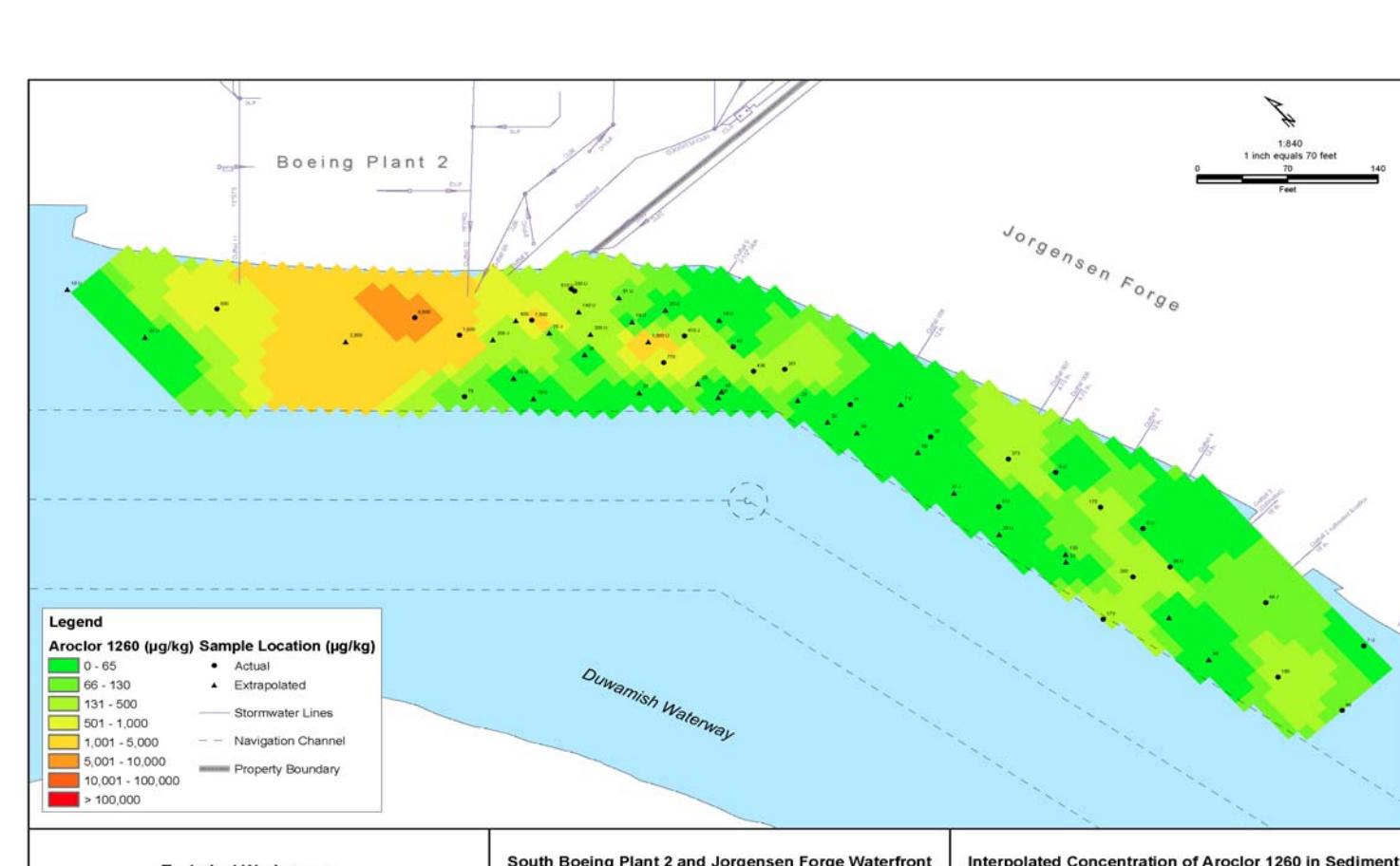
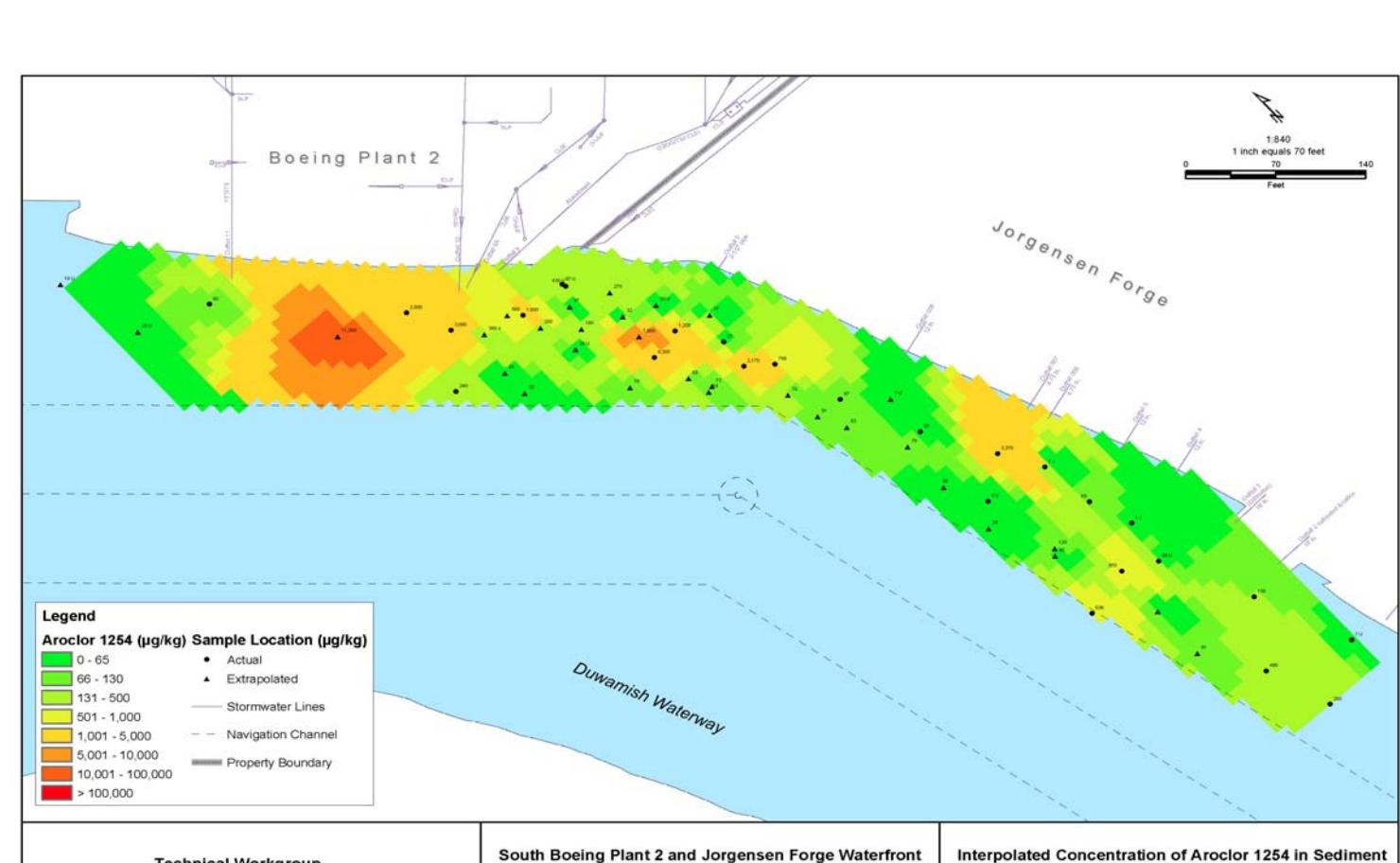
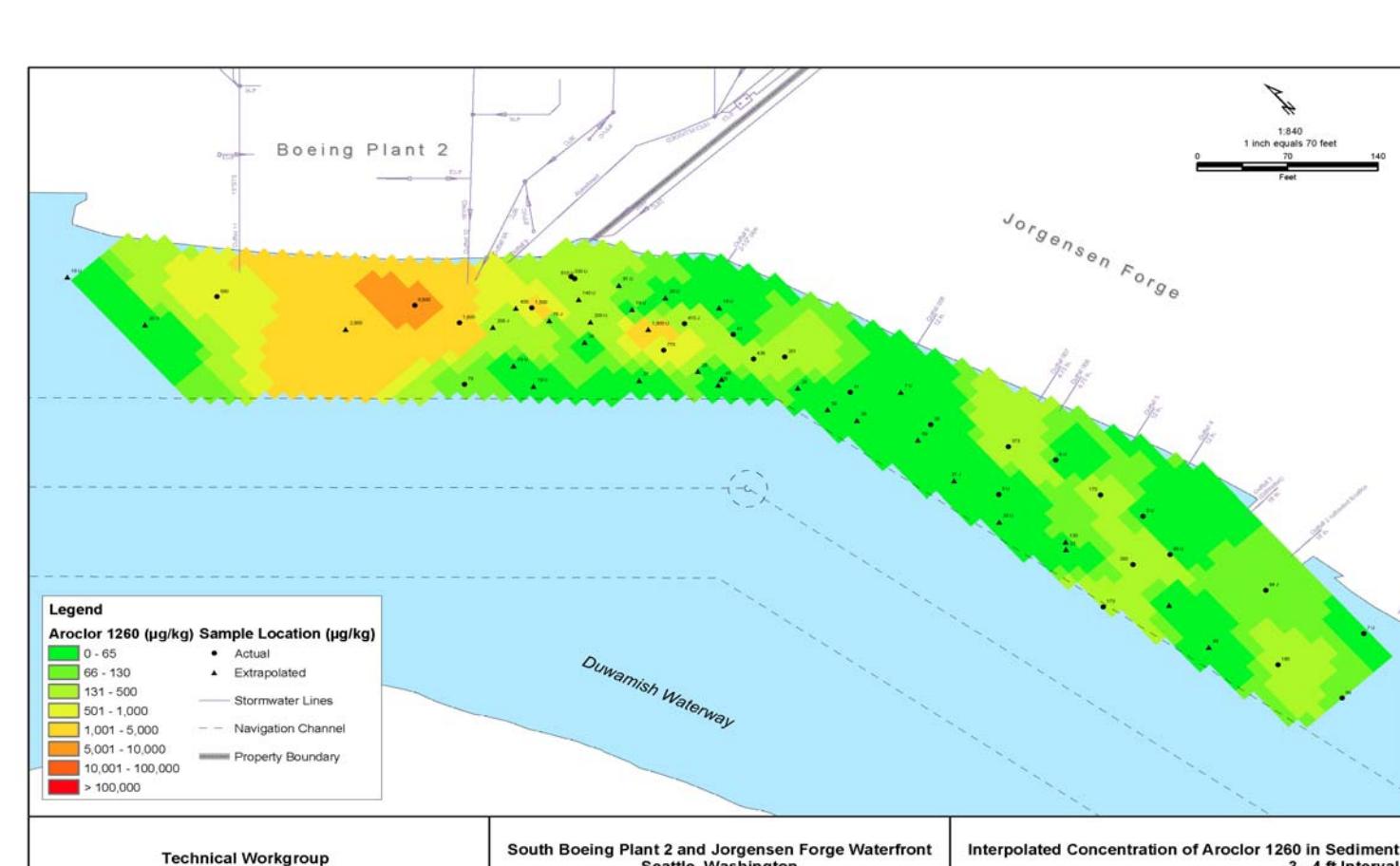
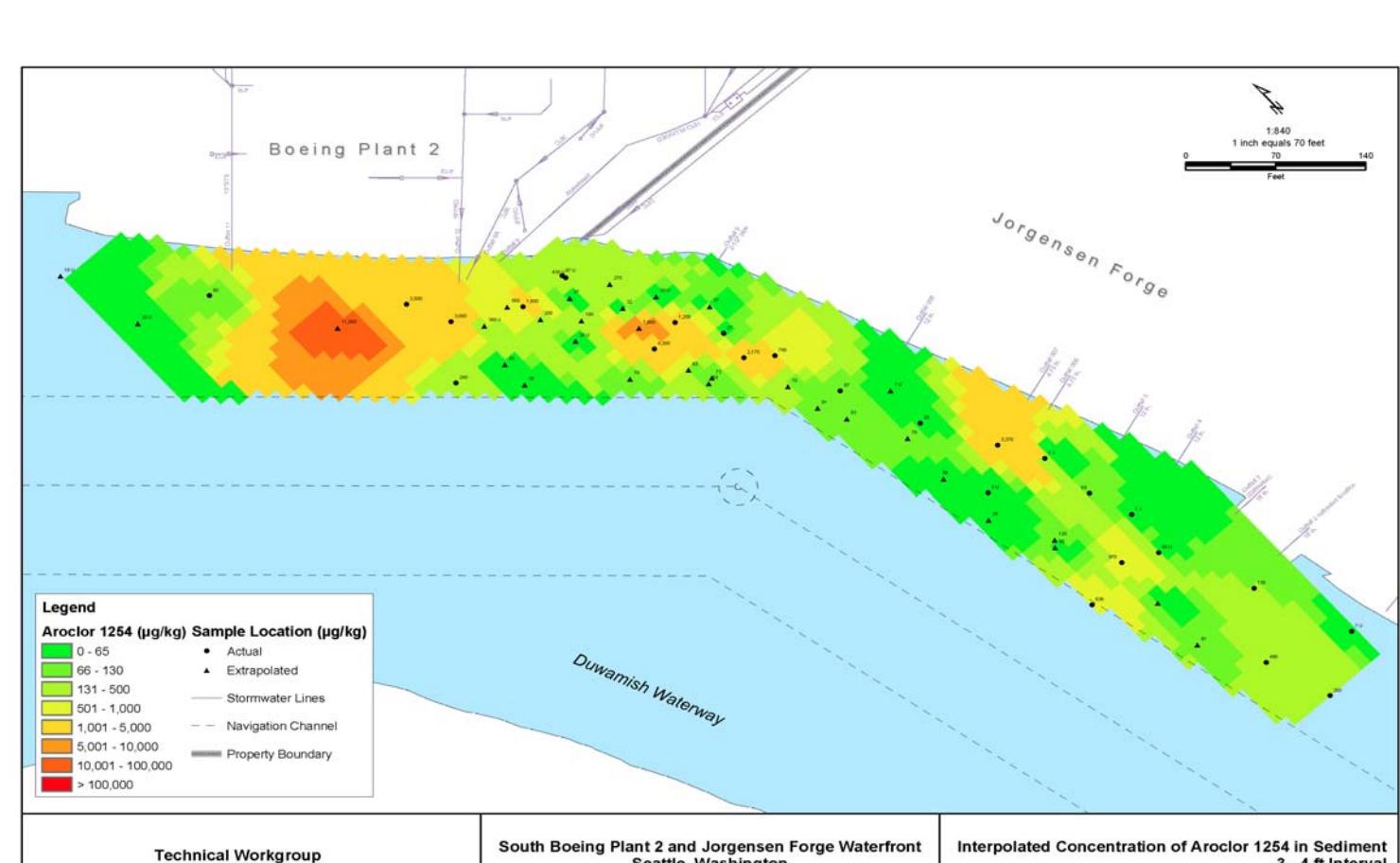
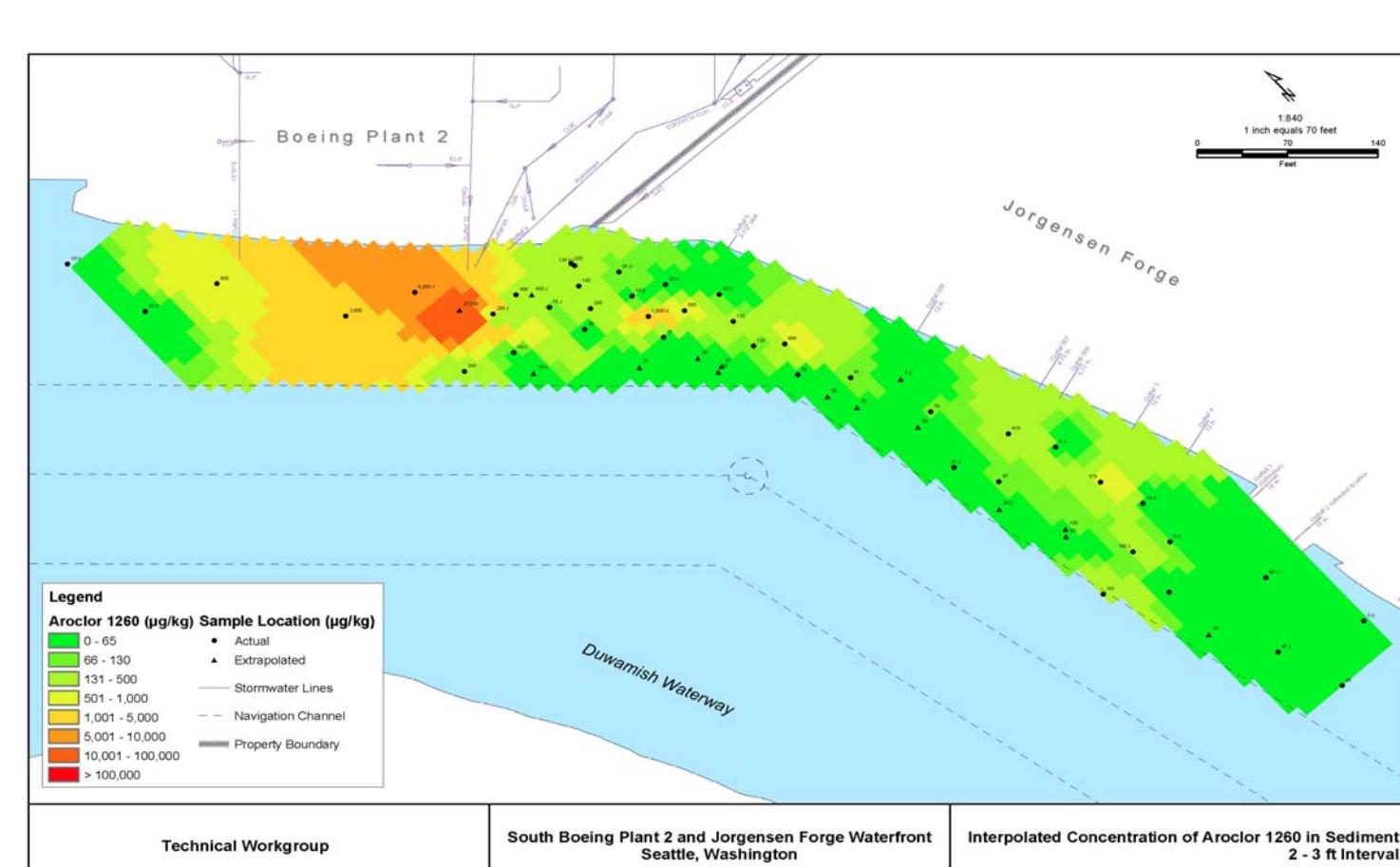
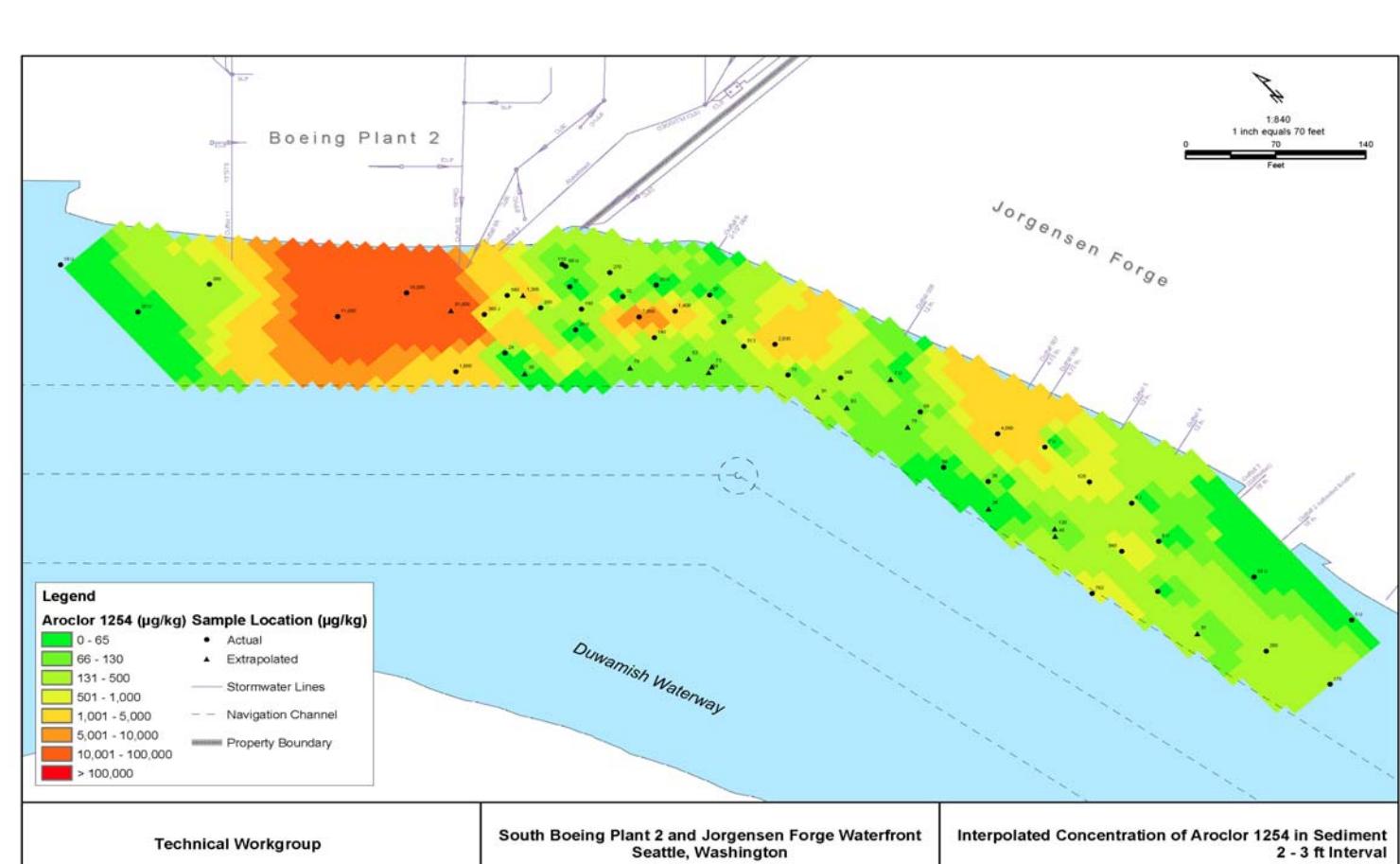
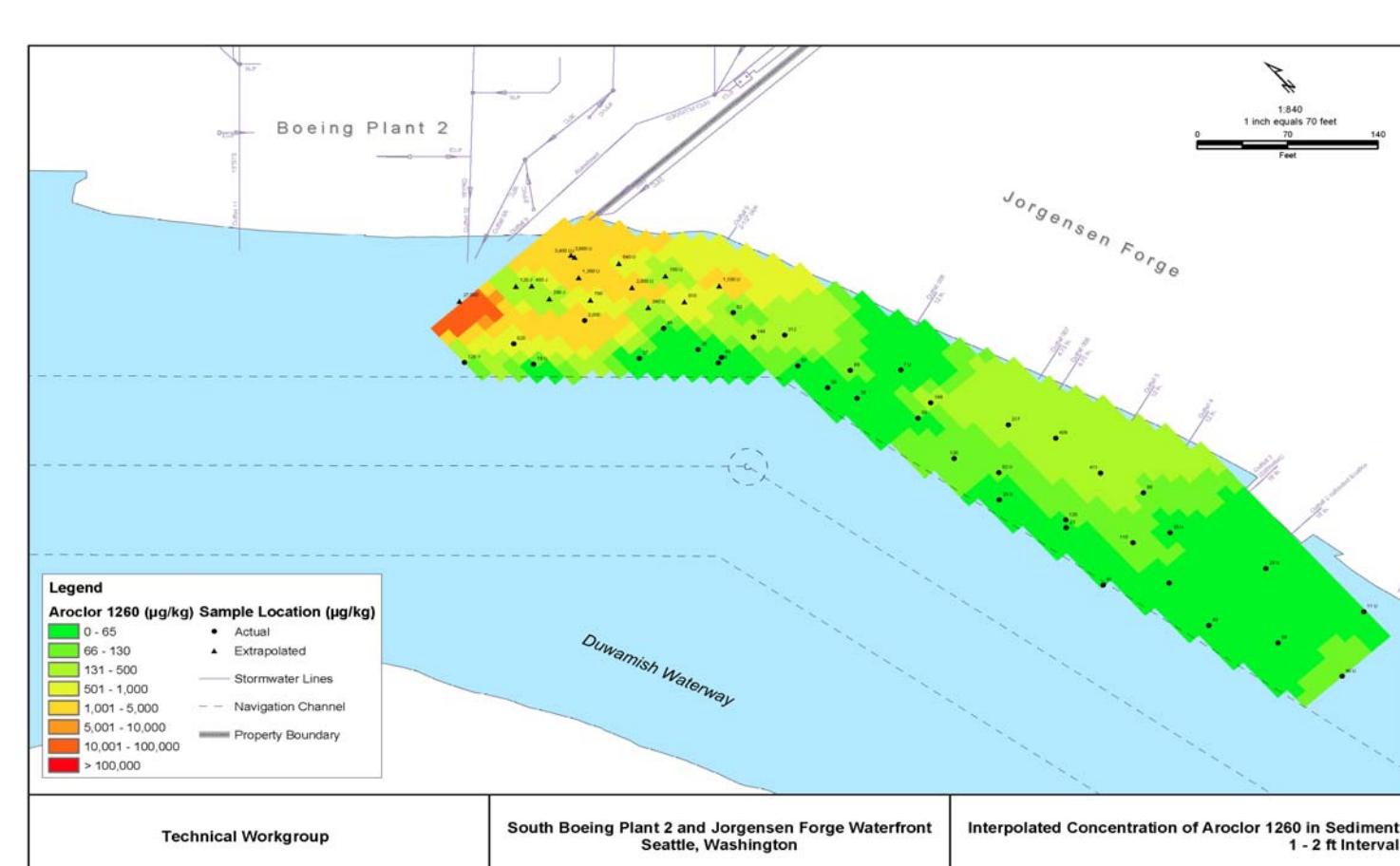
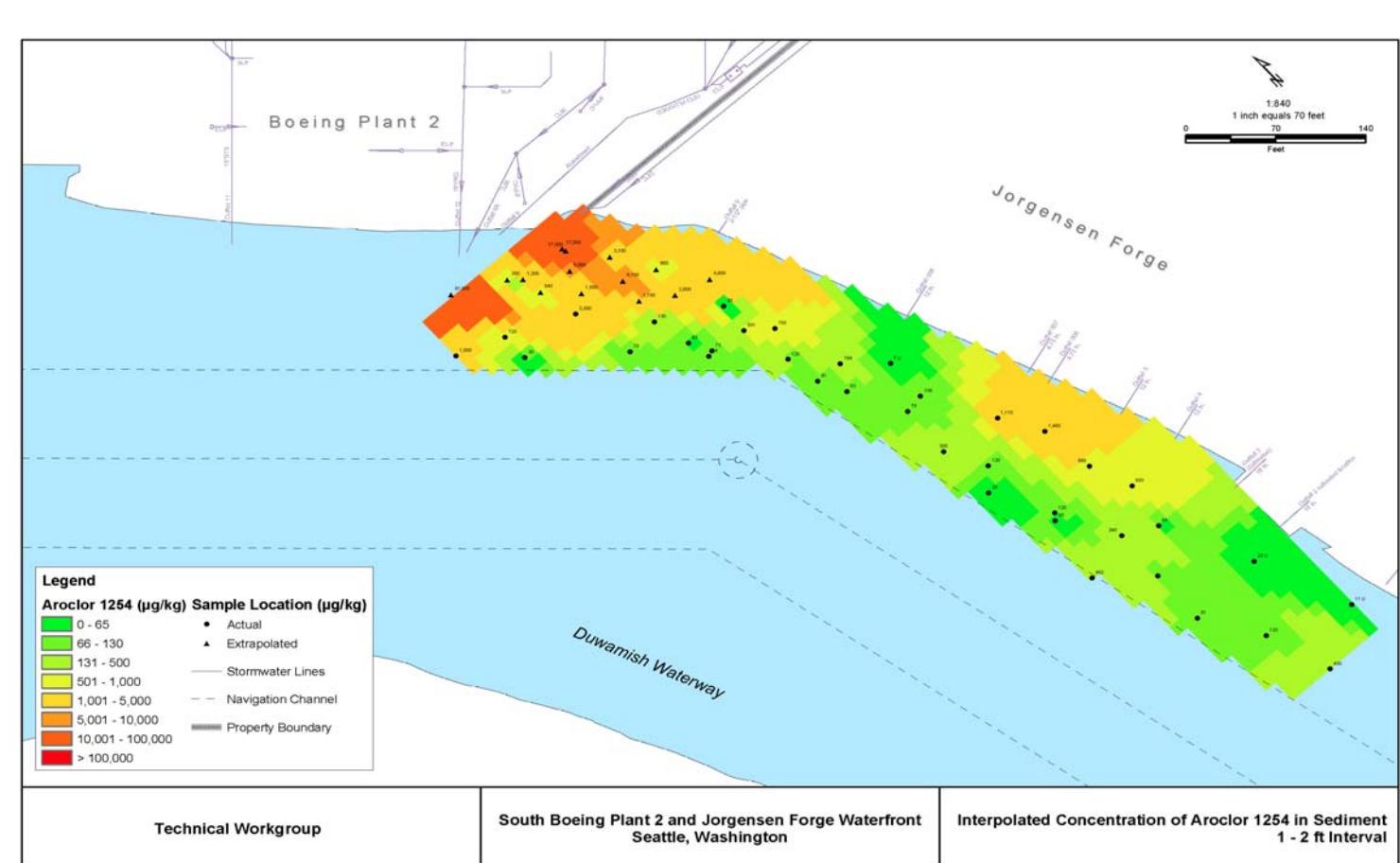
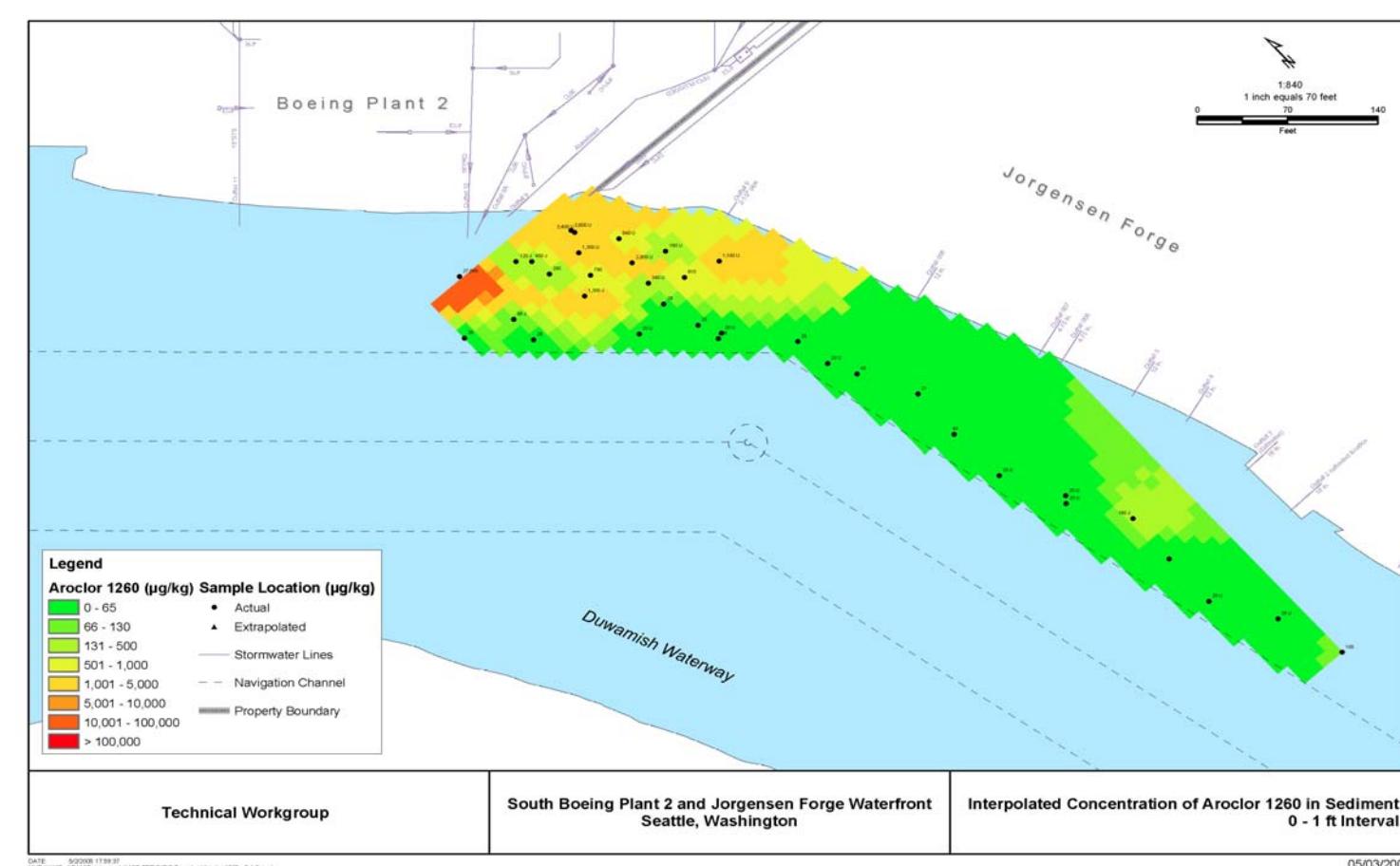
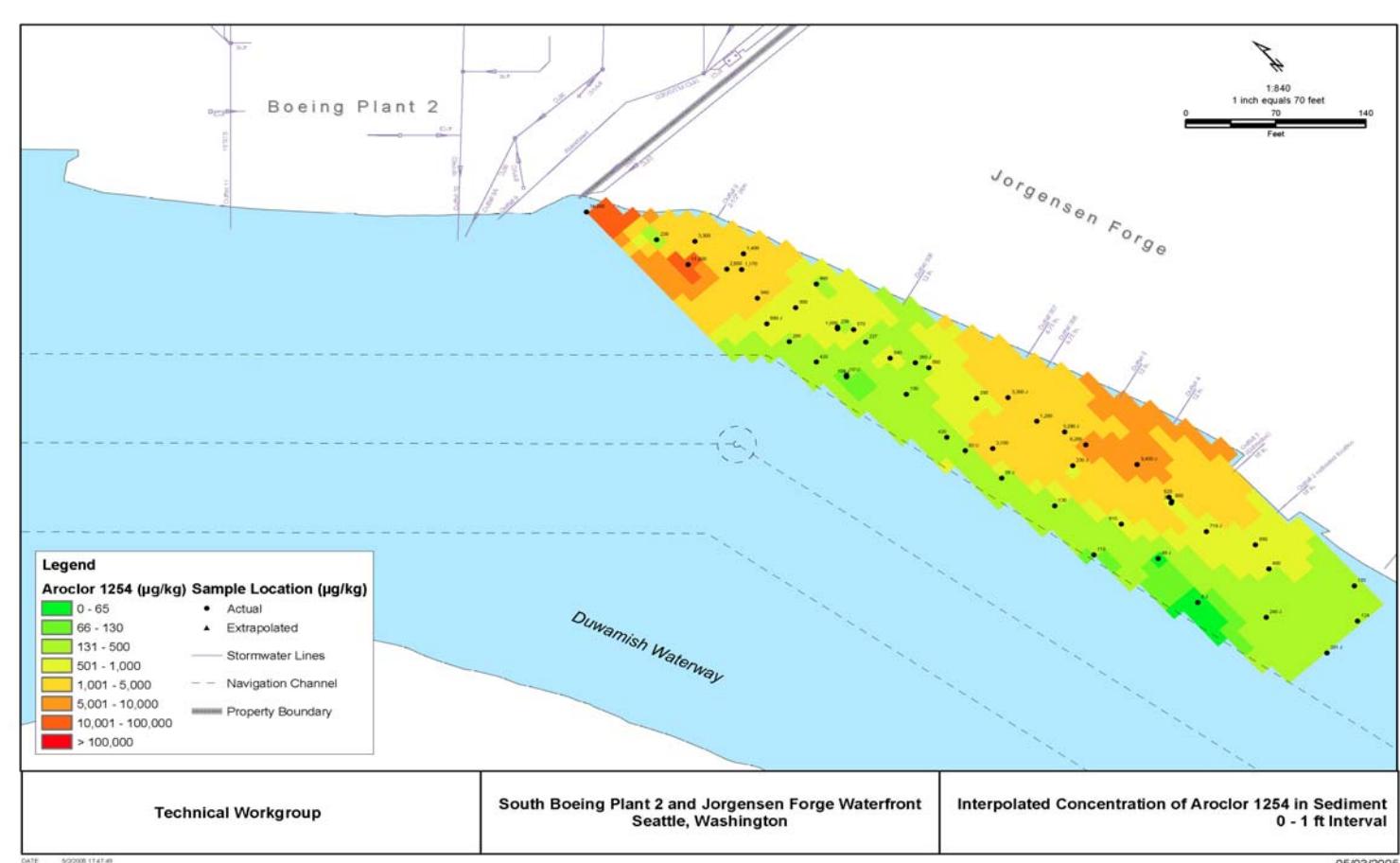
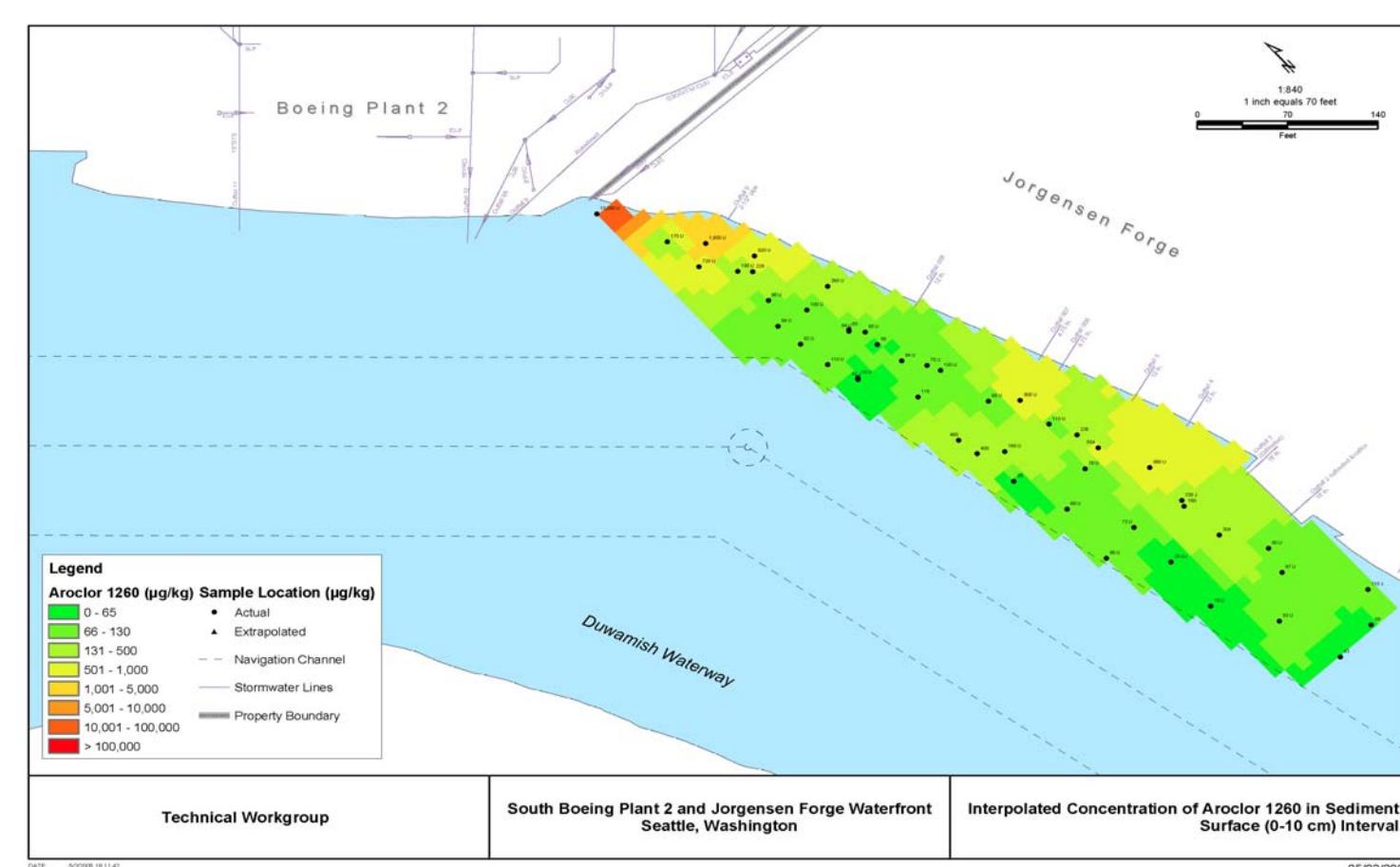
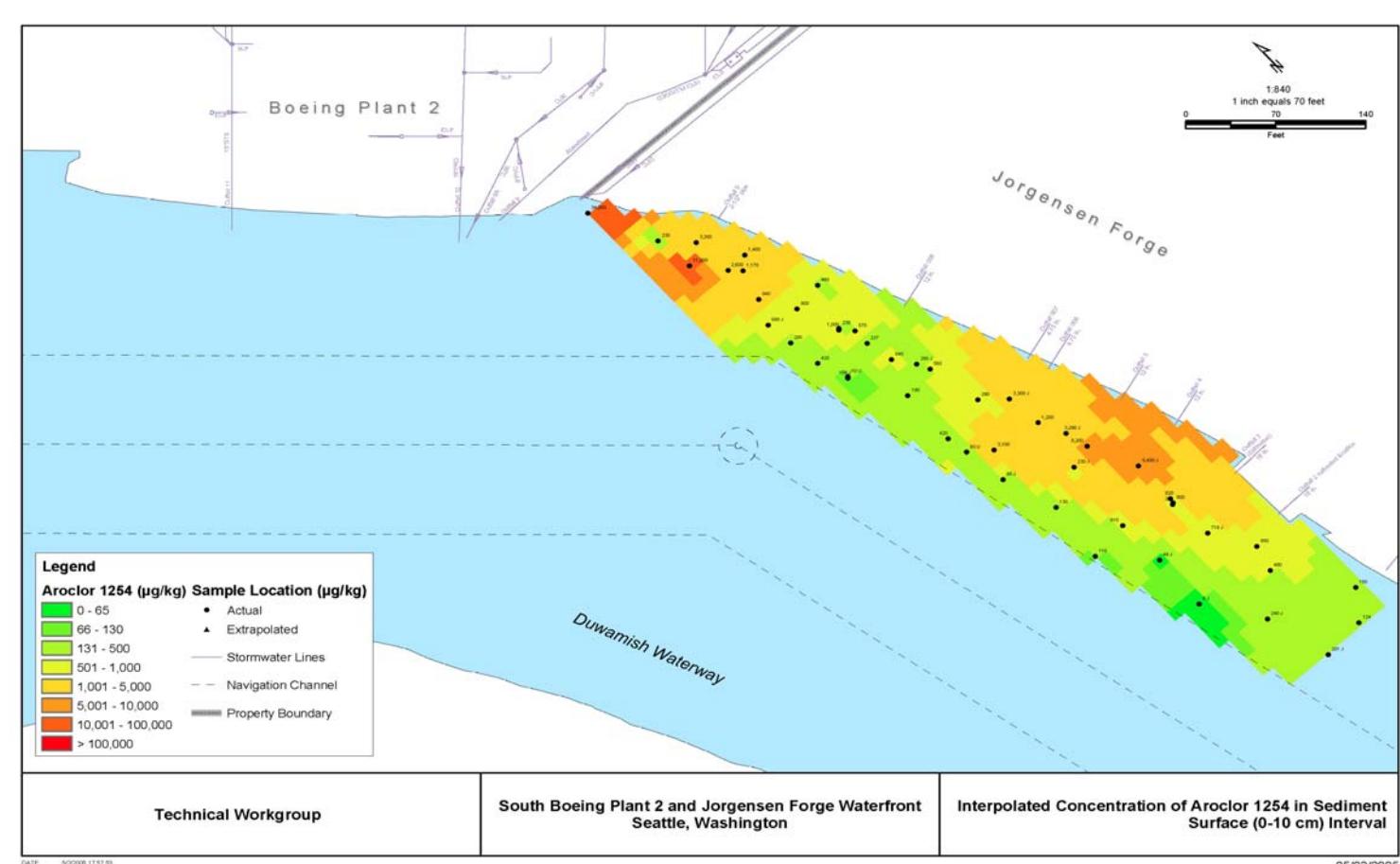
## **South Boeing Plant 2 and Jorgensen Forge Waterfront Seattle, Washington**

## Interpolated Concentration of Aroclor 1260 in Sediment 3 - 4 ft Interval

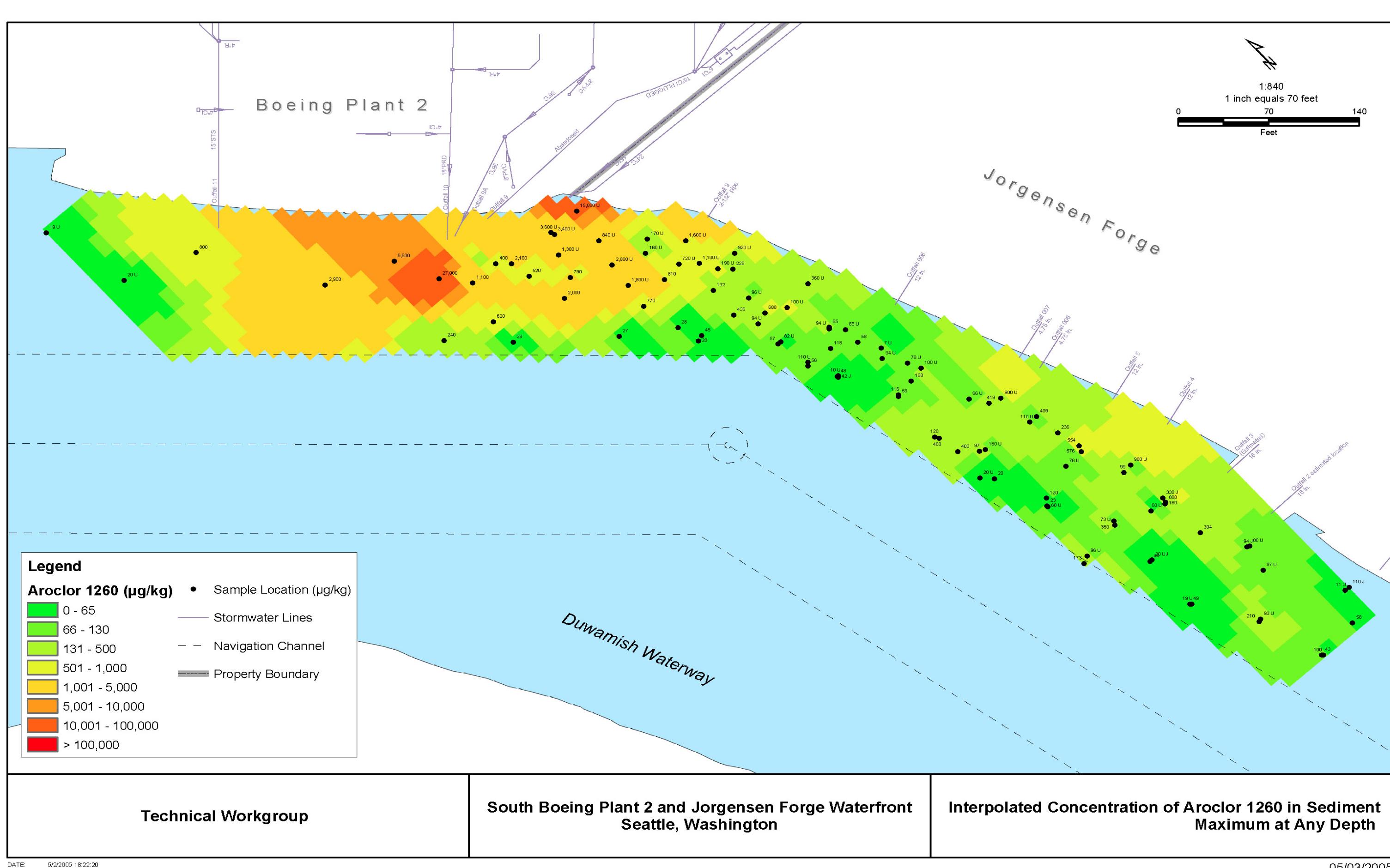
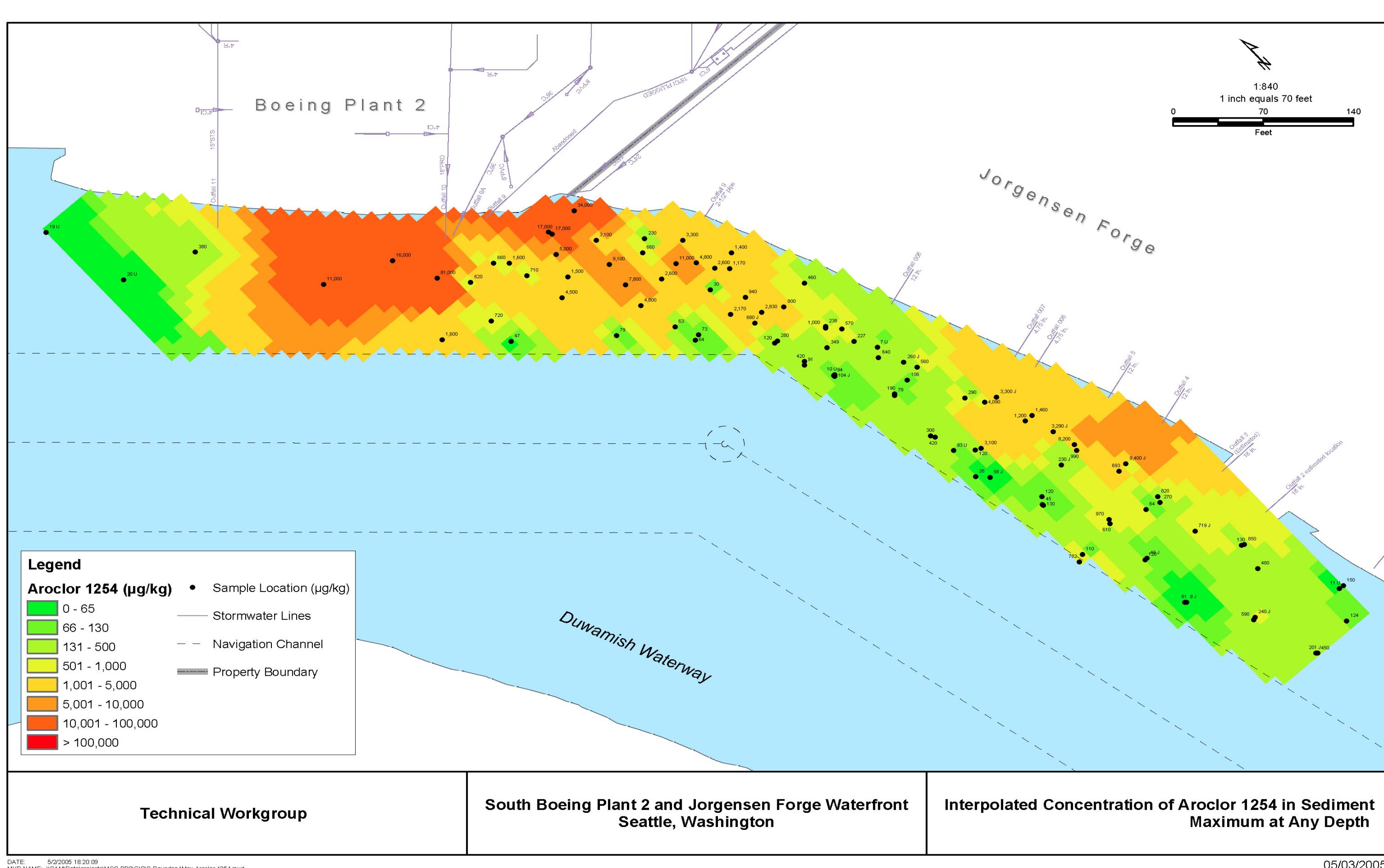
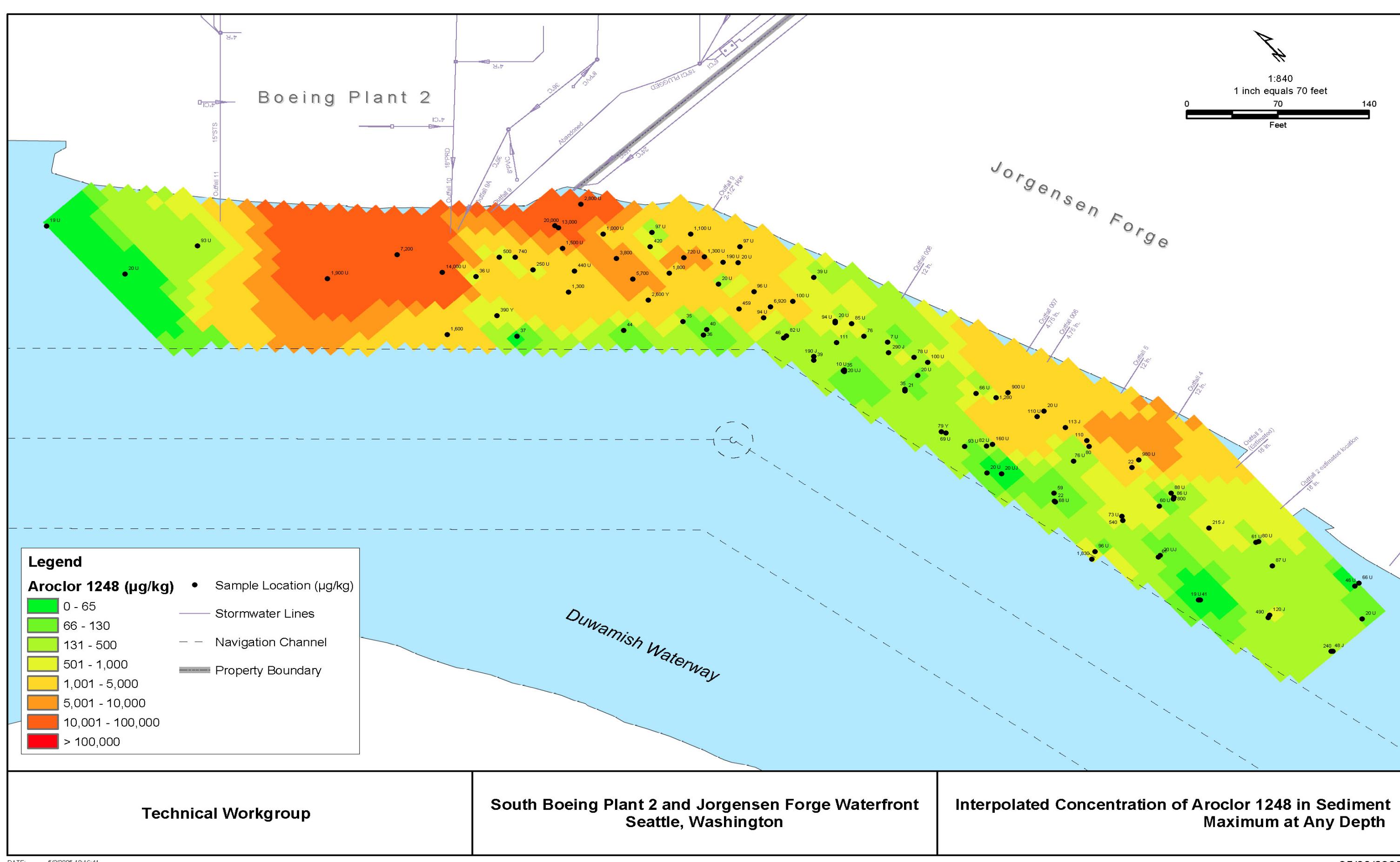


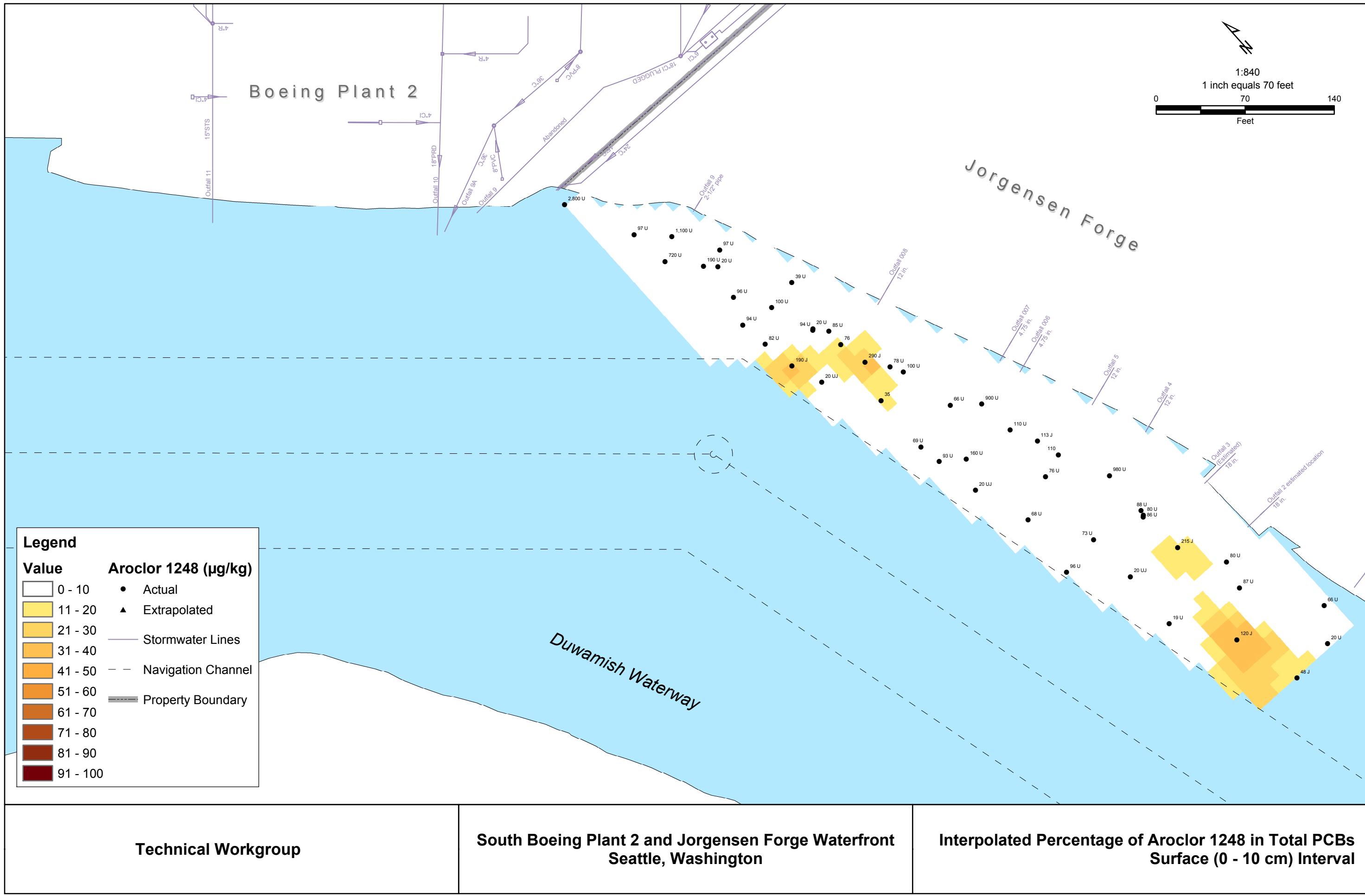


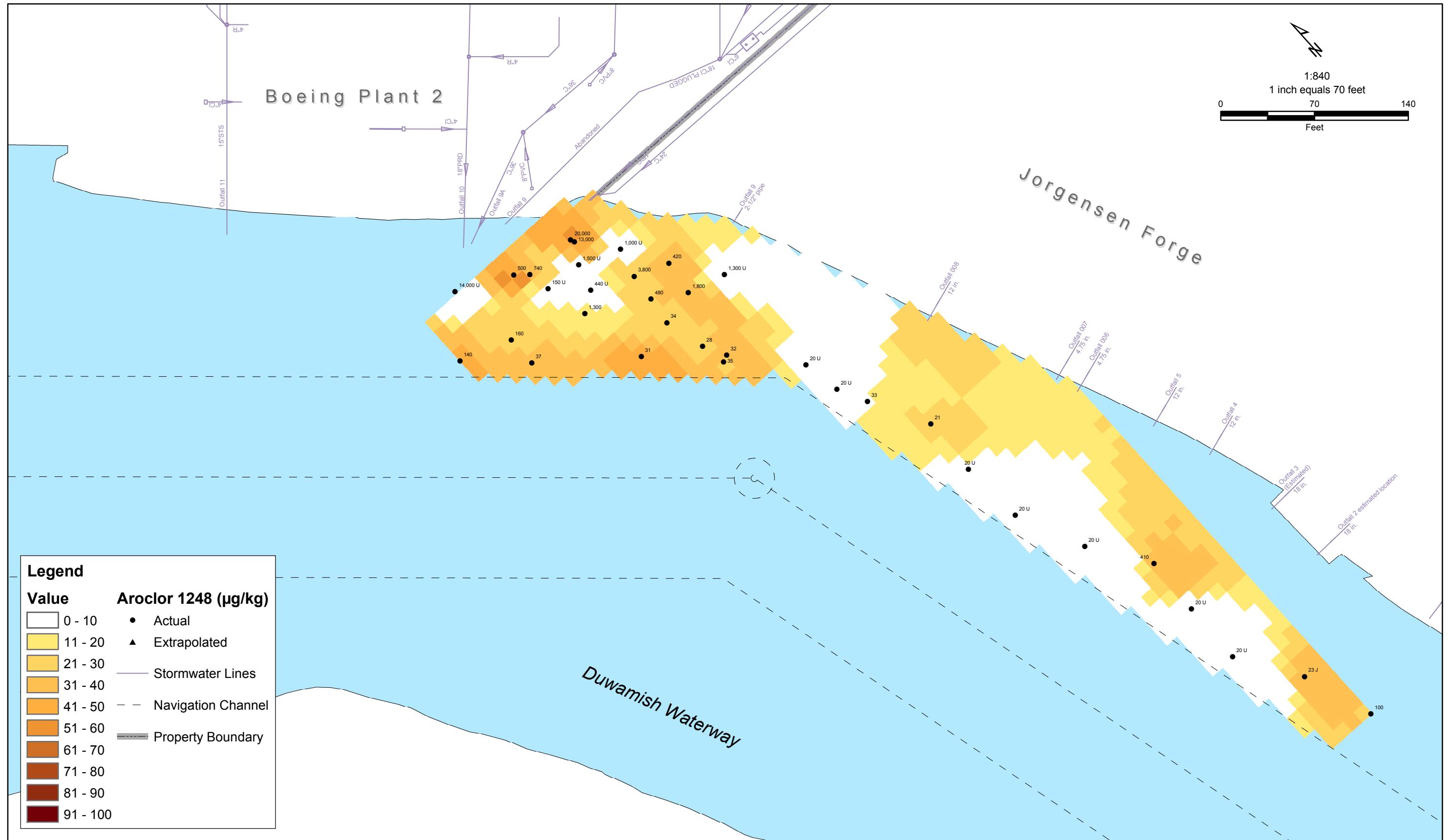
# Aroclor Concentration by Depth Below Mudline



# Maximum Aroclor Concentration at Any Depth



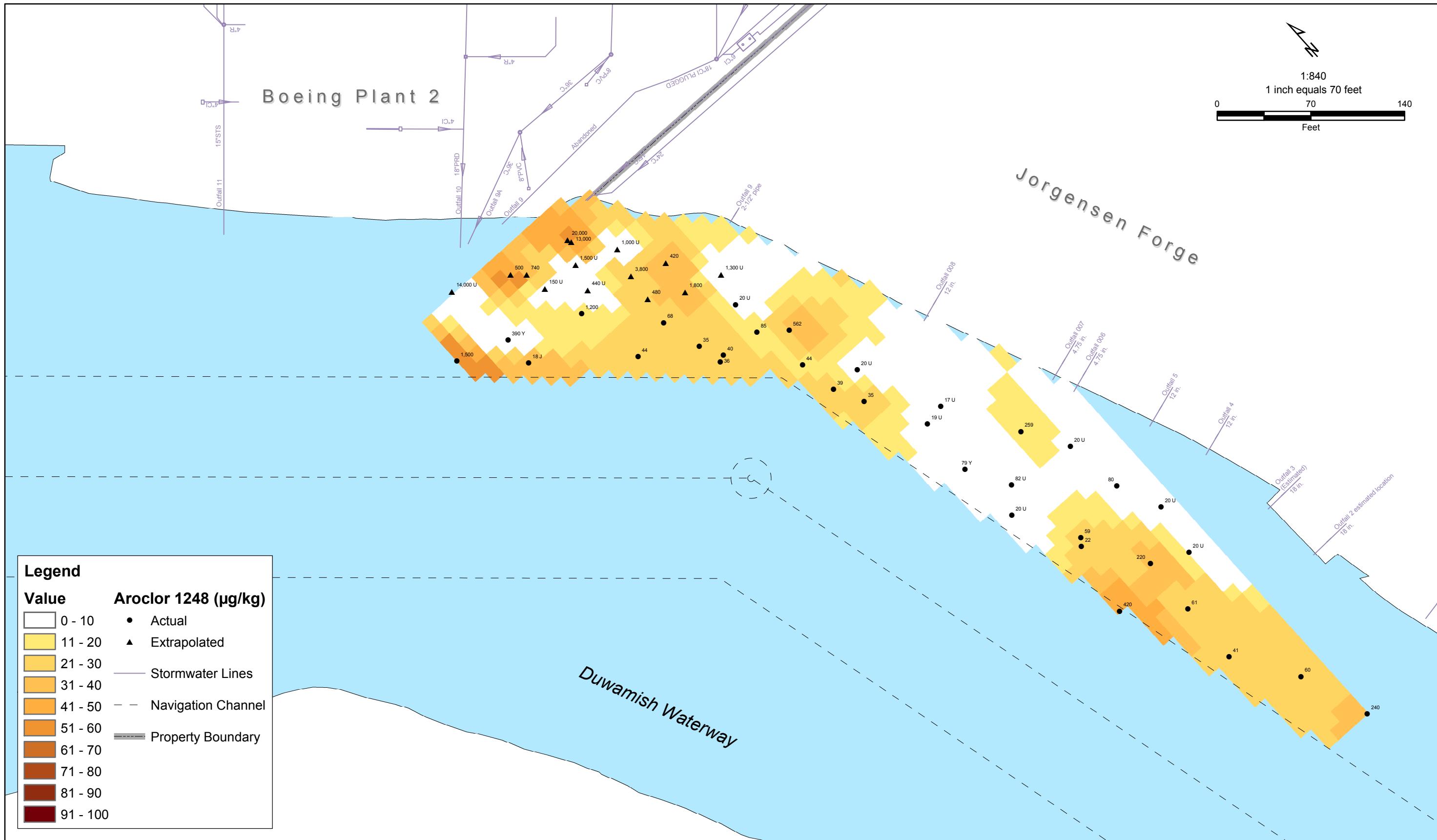


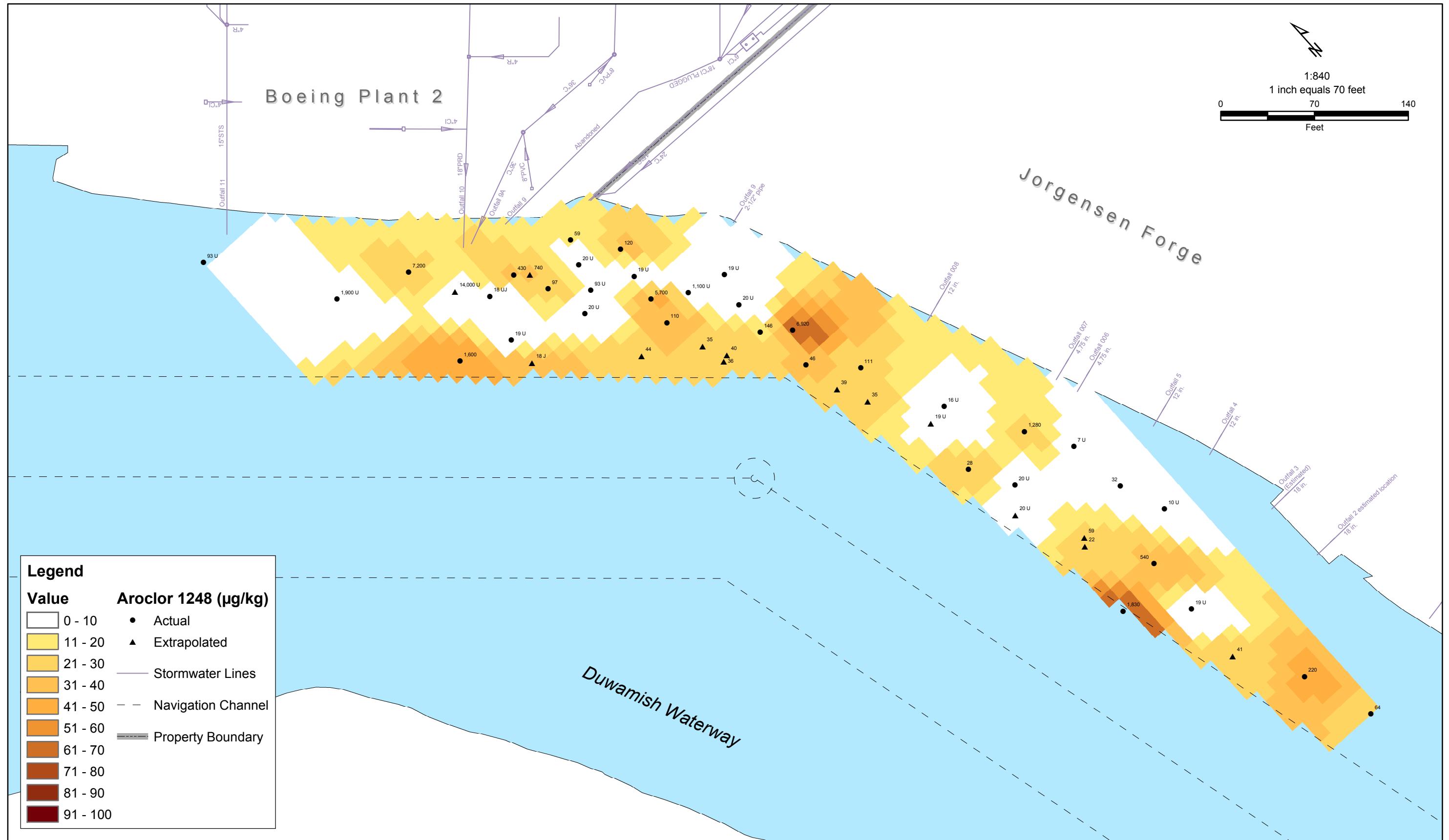


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## **South Boeing Plant 2 and Jorgensen Forge Waterfront Seattle, Washington**

## Interpolated Percentage of Aroclor 1248 in Total PCBs 0 - 1 ft Interval

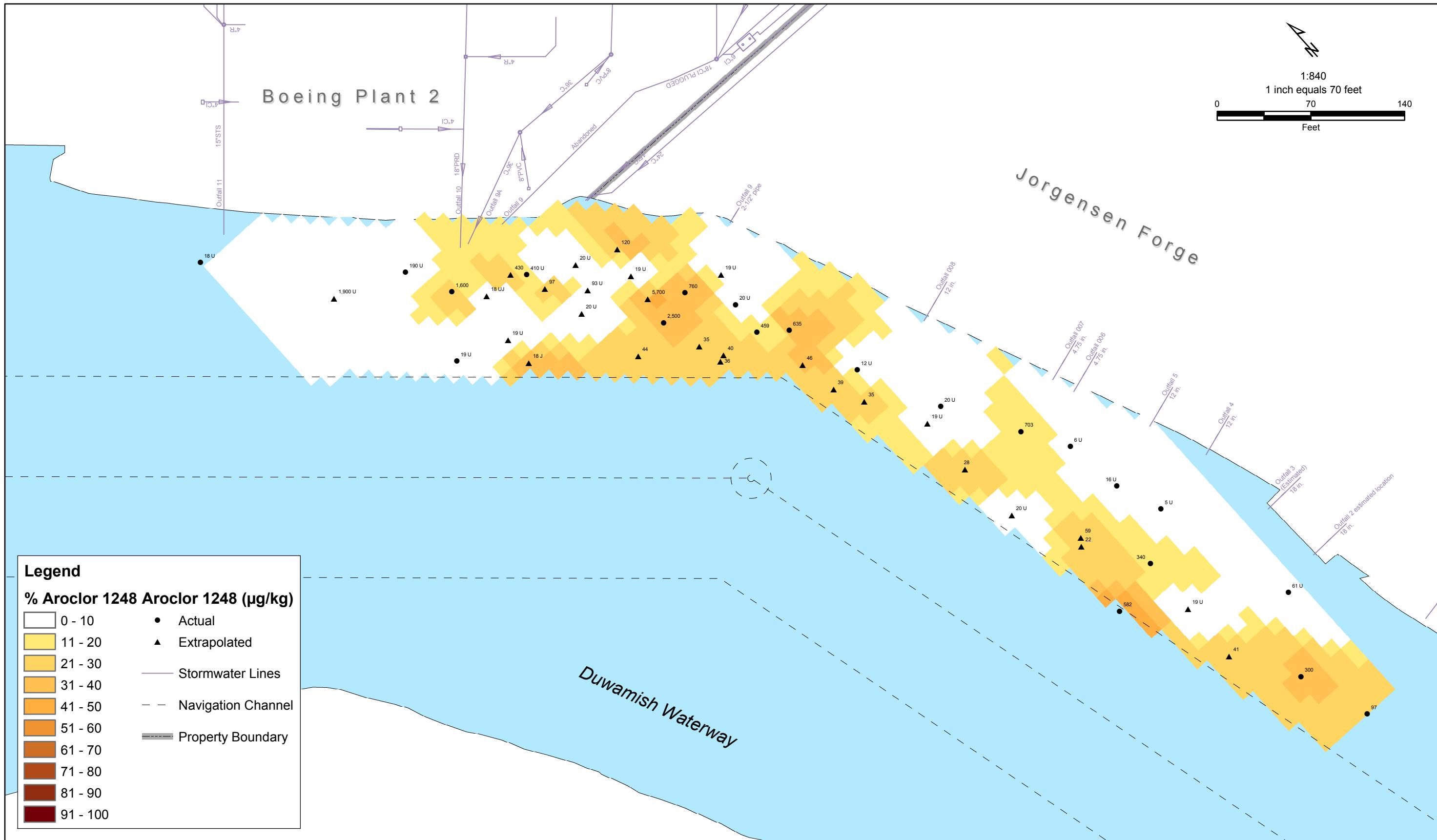




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## **South Boeing Plant 2 and Jorgensen Forge Waterfront Seattle, Washington**

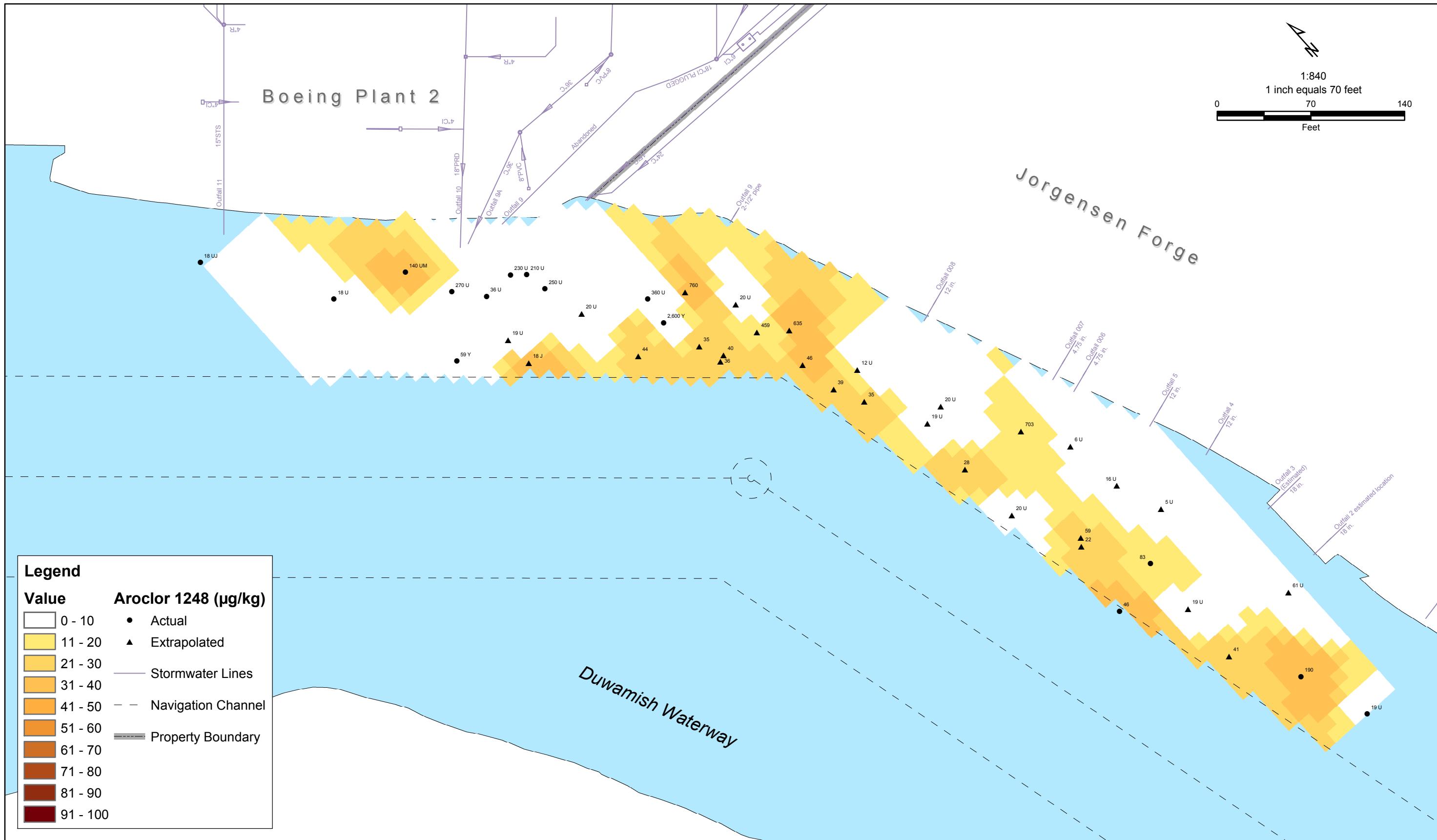
## **Interpolated Percentage of Aroclor 1248 in Total PCBs 2 - 3 ft Interval**



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South Boeing Plant 2 and Jorgensen Forge Waterfront  
Seattle, Washington

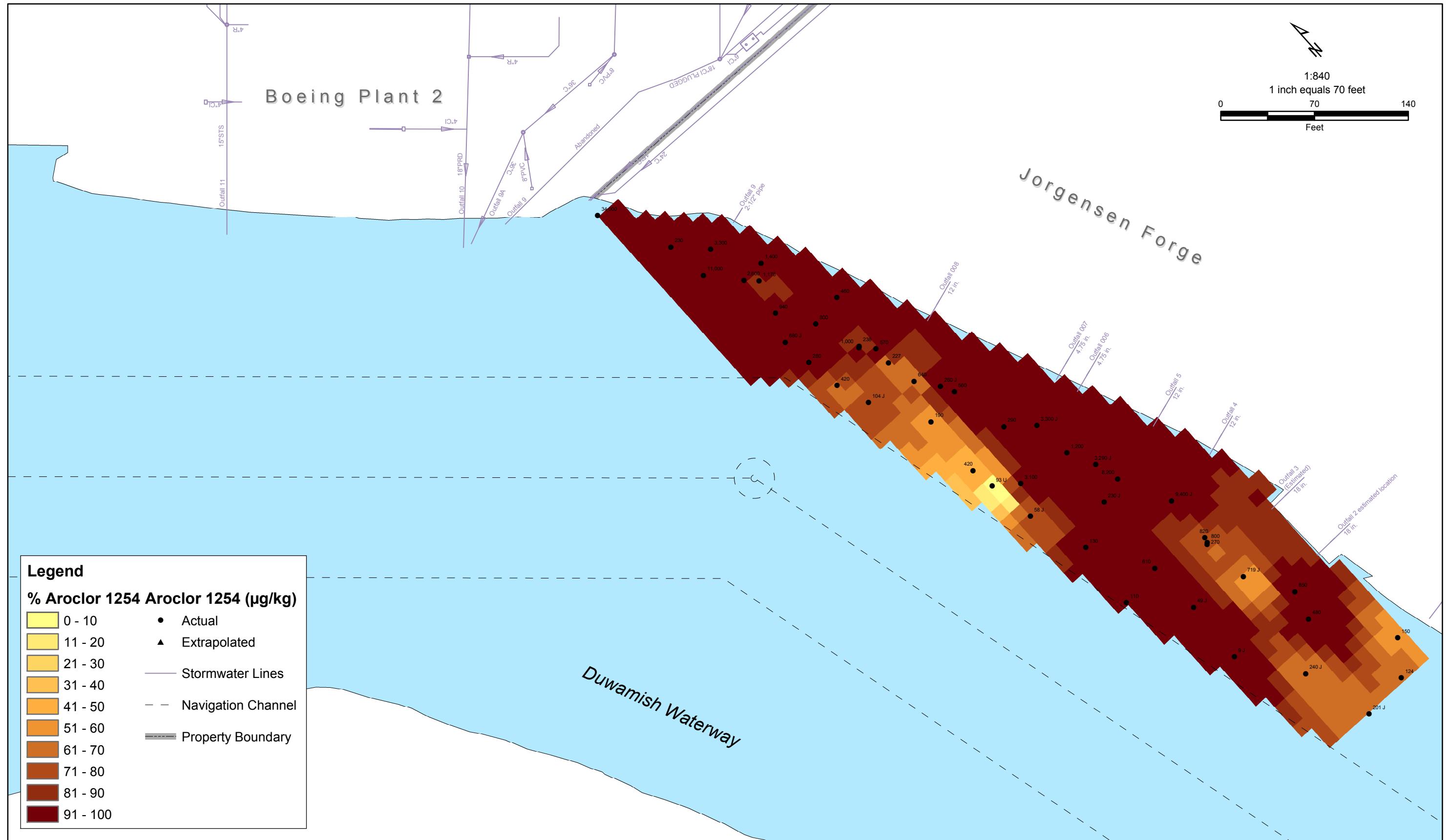
Interpolated Percentage of Aroclor 1248 in Total PCBs  
3 - 4 ft Interval



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South Boeing Plant 2 and Jorgensen Forge Waterfront  
Seattle, Washington

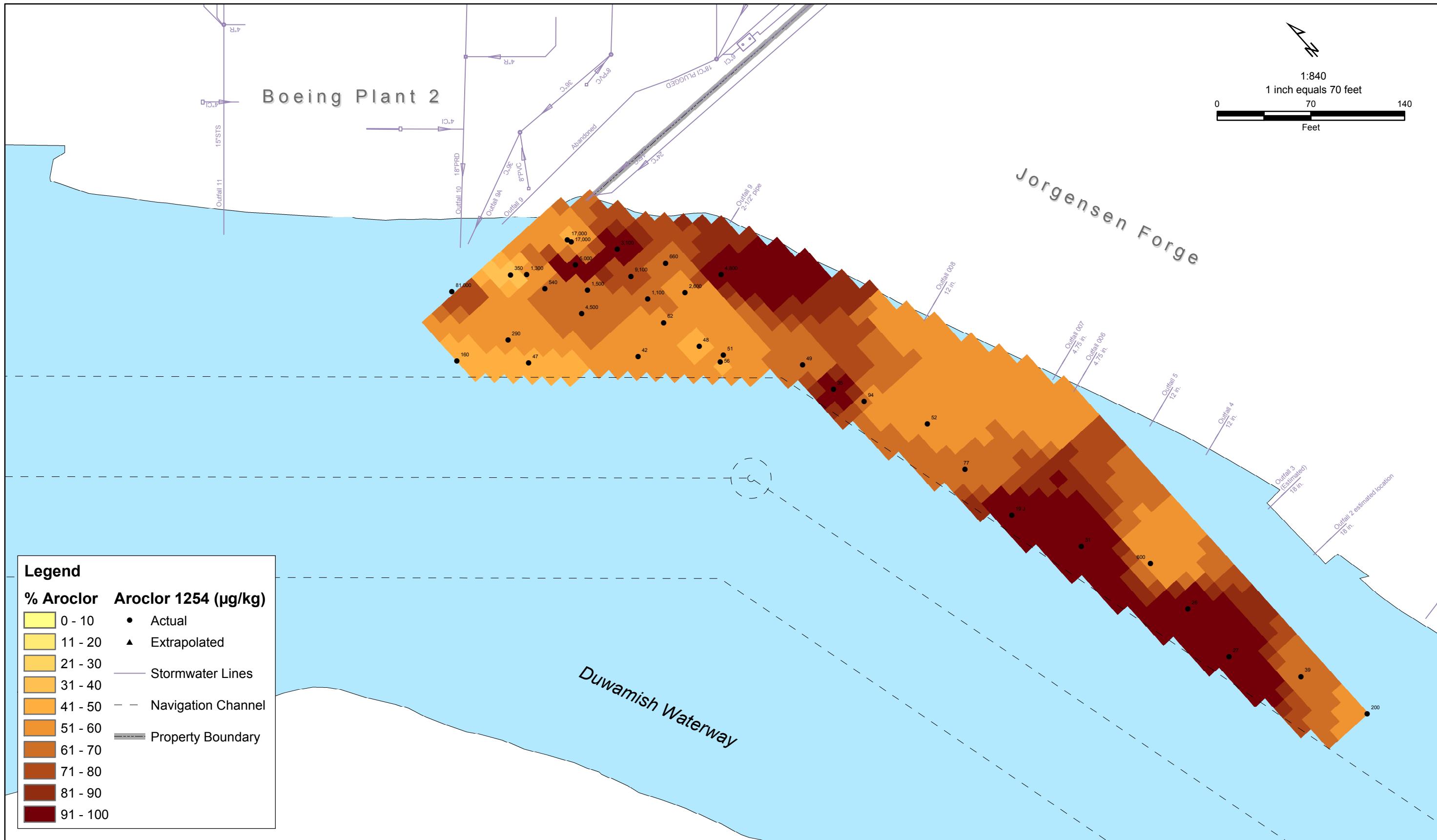
Interpolated Percentage of Aroclor 1248 in Total PCBs  
4 - 5 ft Interval



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## **South Boeing Plant 2 and Jorgensen Forge Waterfront Seattle, Washington**

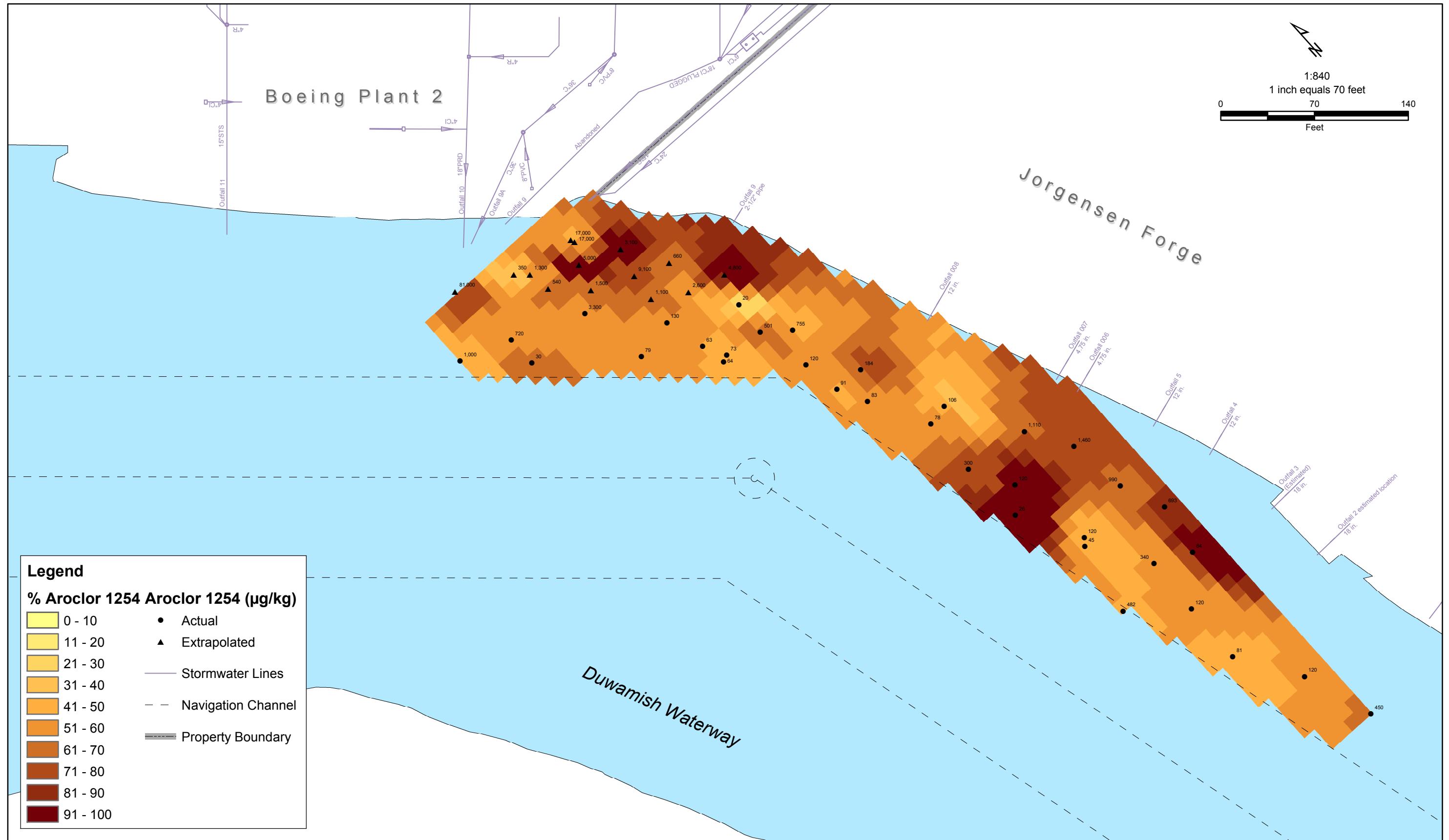
## **Interpolated Percentage of Aroclor 1254 in Total PCBs Surface (0 - 10 cm) Interval**



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South Boeing Plant 2 and Jorgensen Forge Waterfront  
Seattle, Washington

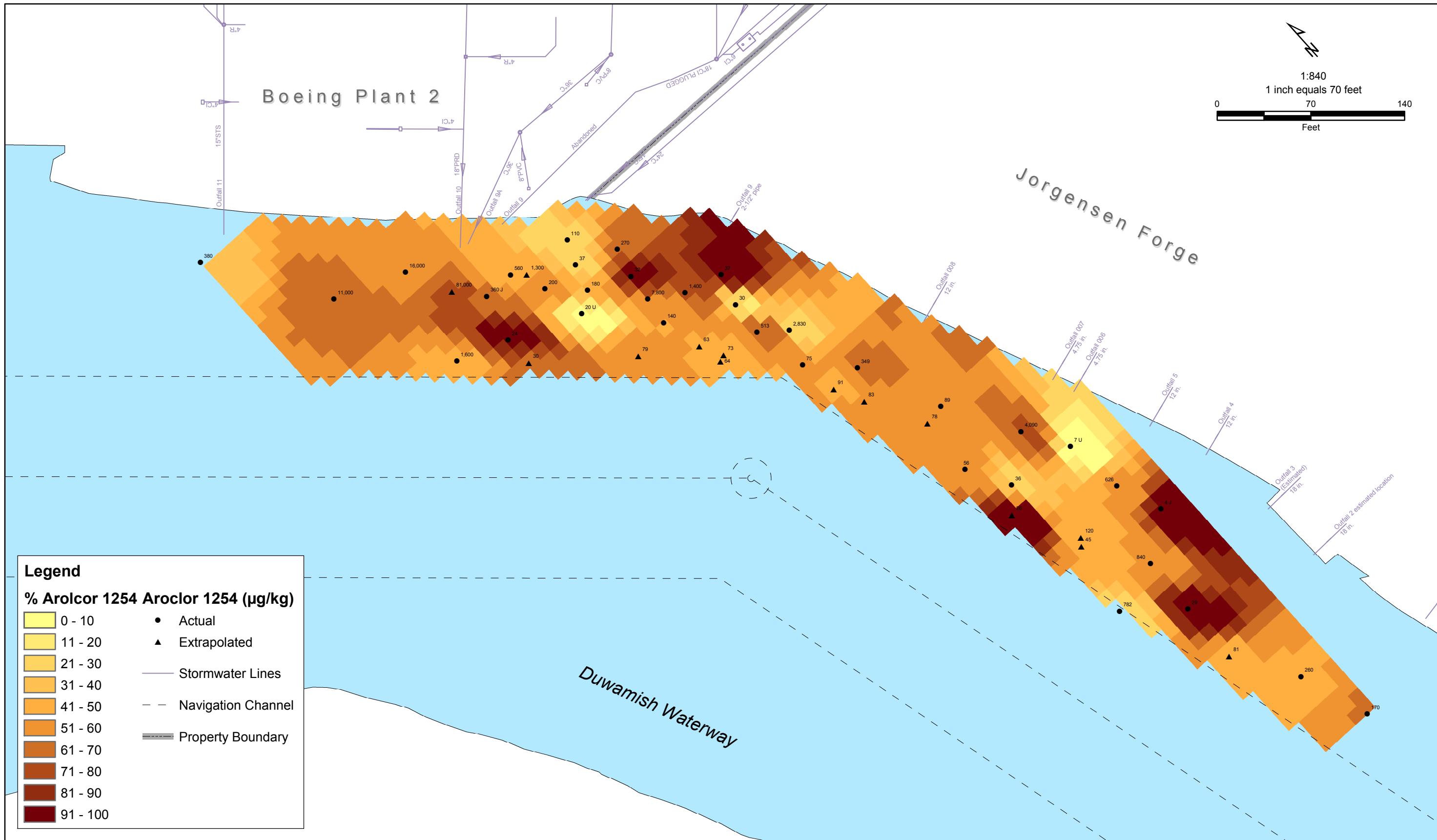
Interpolated Percentage of Aroclor 1254 in Total PCBs  
0 - 1 ft Interval



## **Technical Workgroup**

## **South Boeing Plant 2 and Jorgensen Forge Waterfront Seattle, Washington**

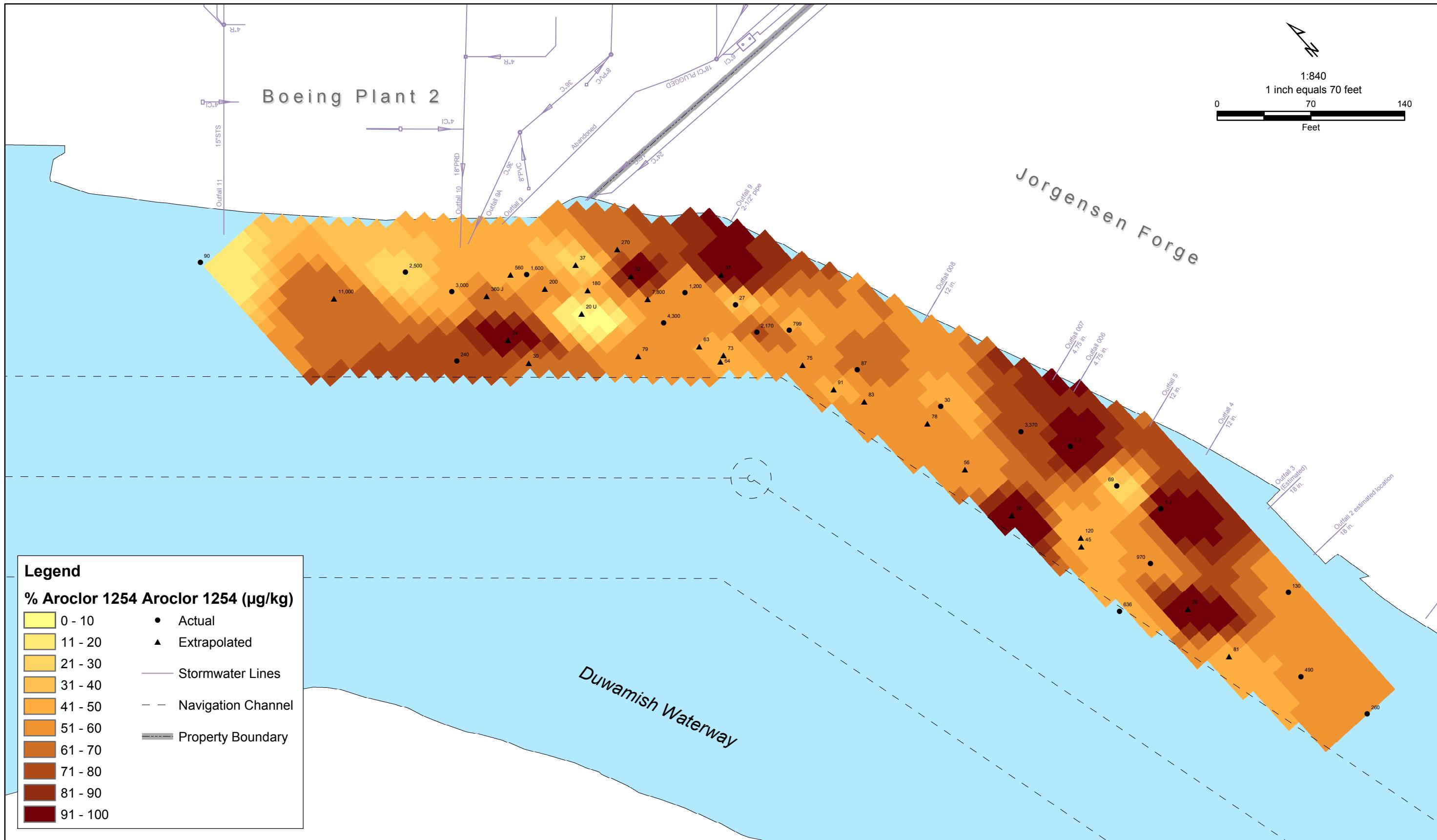
## **Interpolated Percentage of Aroclor 1254 in Total PCBs 1 - 2 ft Interval**



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South Boeing Plant 2 and Jorgensen Forge Waterfront  
Seattle, Washington

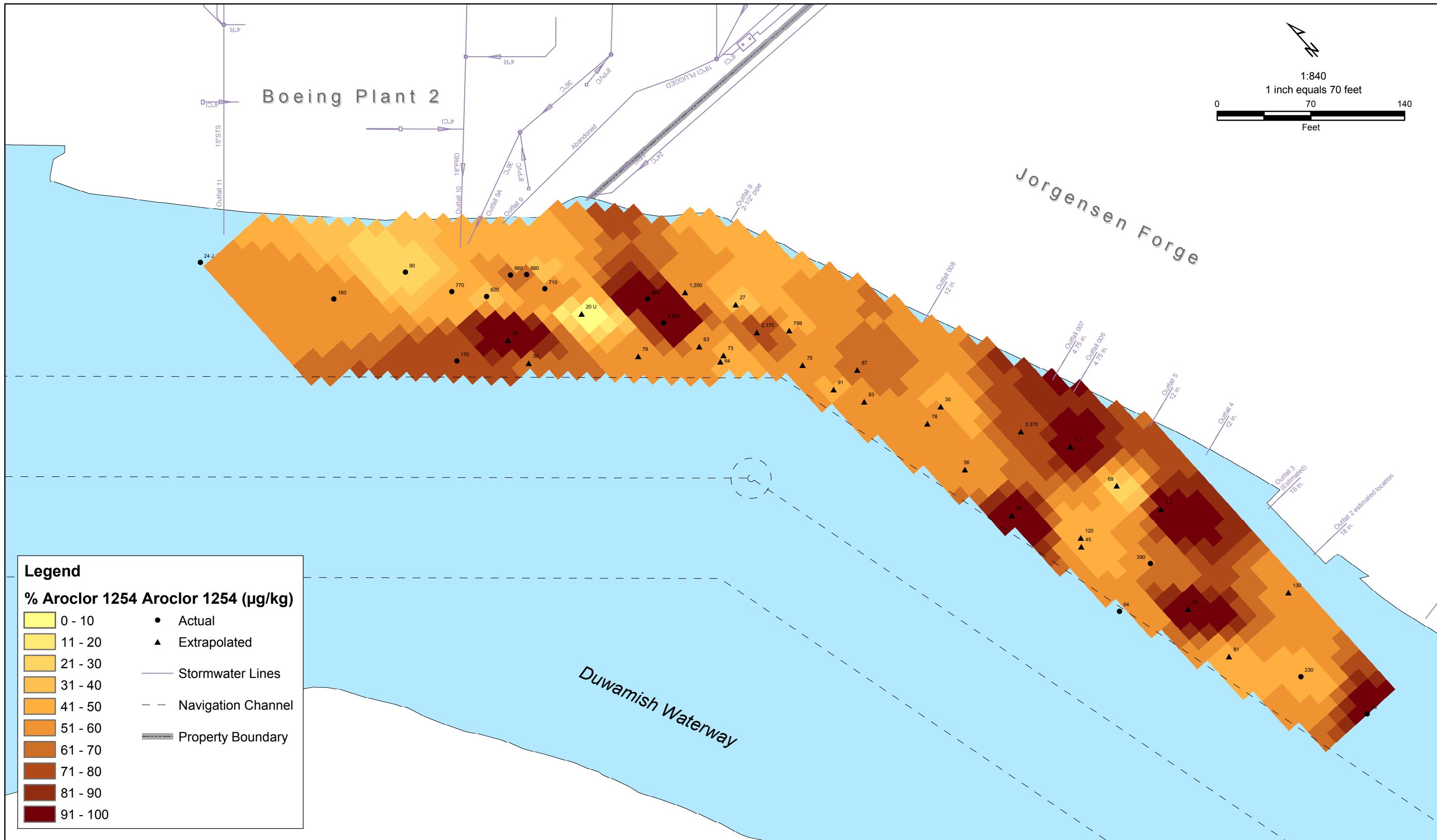
Interpolated Percentage of Aroclor 1254 in Total PCBs  
2 - 3 ft Interval



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Seattle, Washington

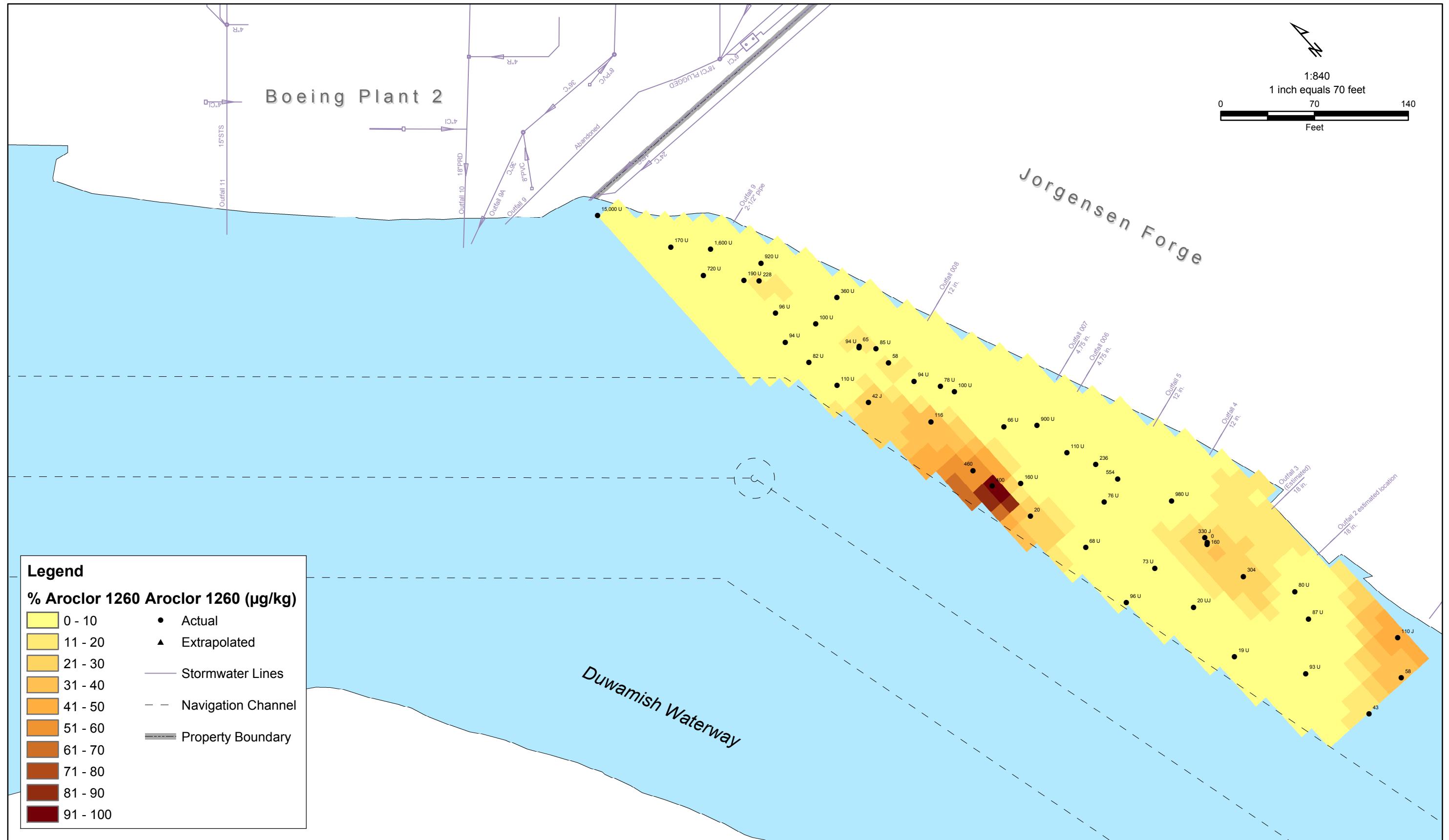
Interpolated Percentage of Aroclor 1254 in Total PCBs  
3 - 4 ft Interval



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South Boeing Plant 2 and Jorgensen Forge Waterfront  
Seattle, Washington

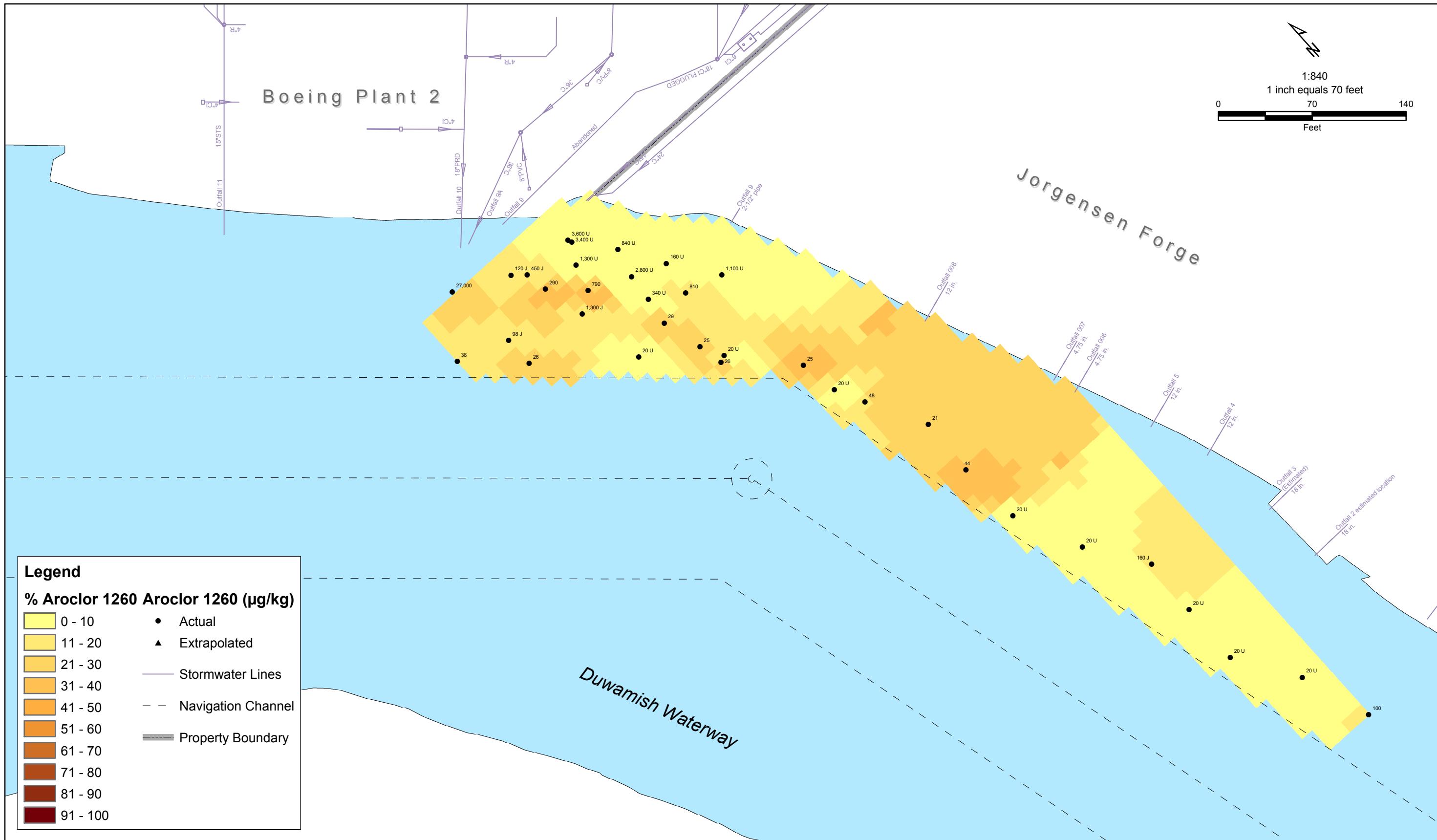
Interpolated Percentage of Aroclor 1254 in Total PCBs  
4 - 5 ft Interval



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## **South Boeing Plant 2 and Jorgensen Forge Waterfront Seattle, Washington**

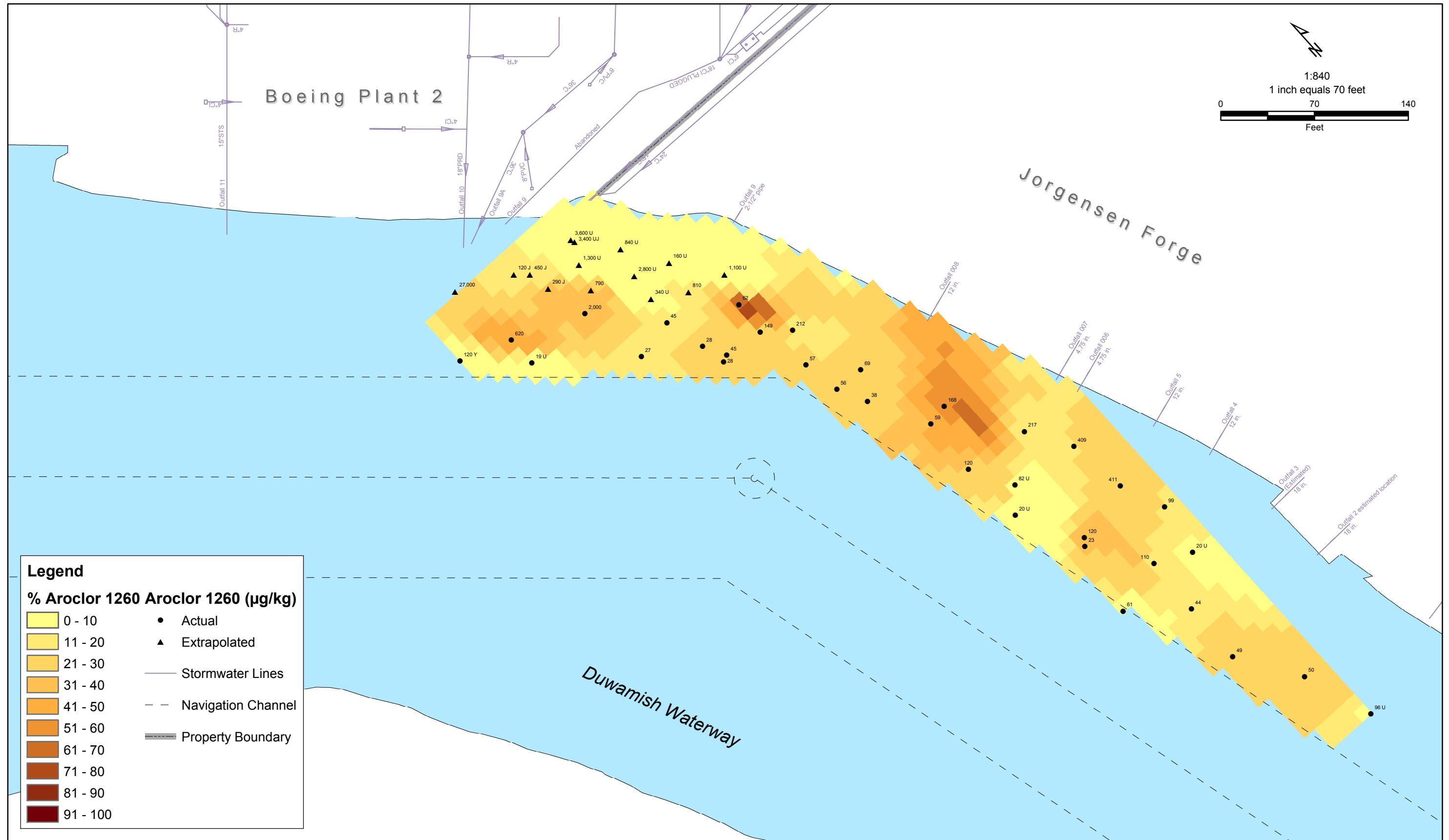
## **Interpolated Percentage of Aroclor 1260 in Total PCBs Surface (0 - 10 cm) Interval**



Technical Workgroup

South Boeing Plant 2 and Jorgensen Forge Waterfront  
Seattle, Washington

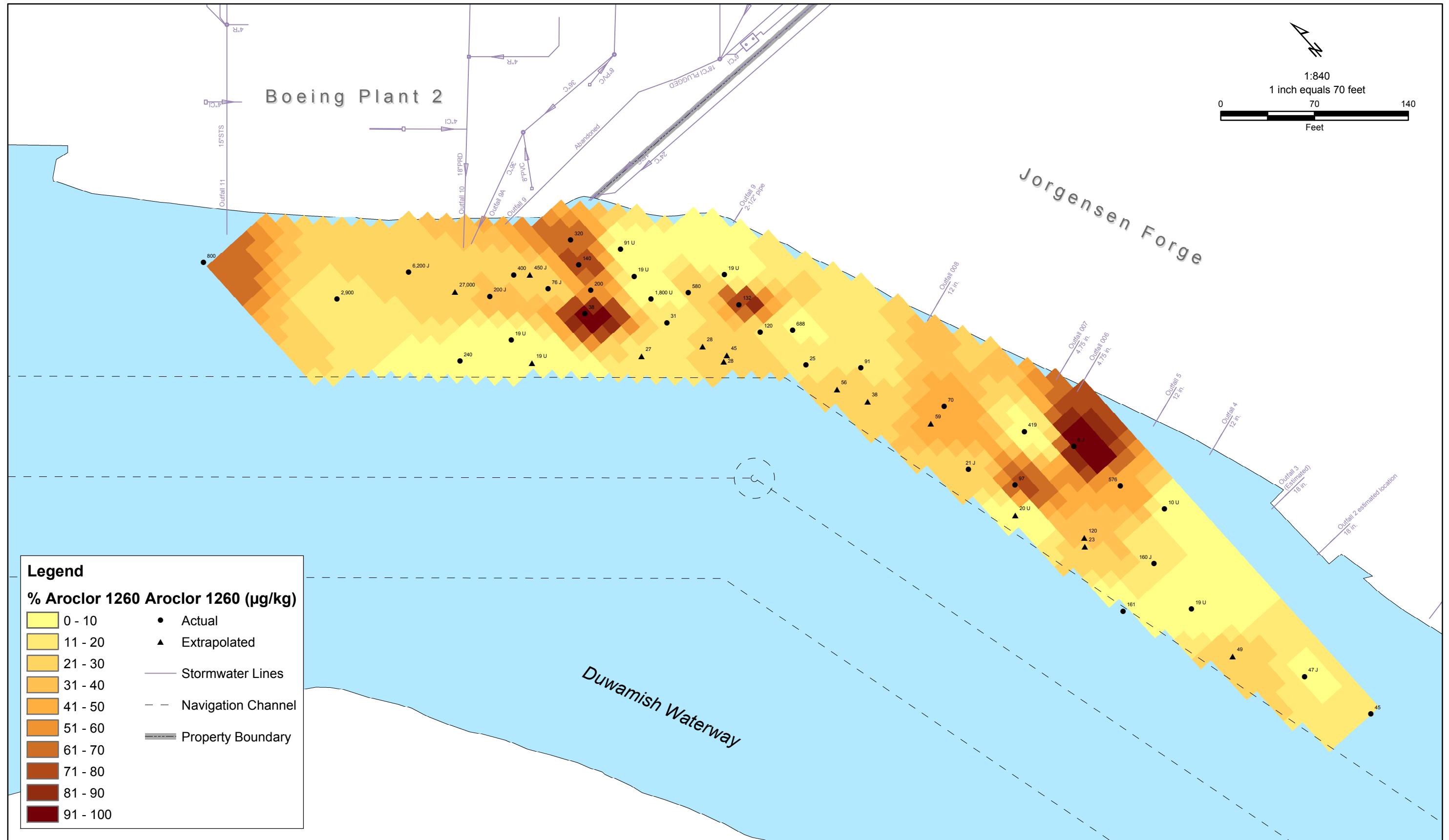
Interpolated Percentage of Aroclor 1260 in Total PCBs  
0 - 1 ft Interval



## Technical Workgroup

## **South Boeing Plant 2 and Jorgensen Forge Waterfront Seattle, Washington**

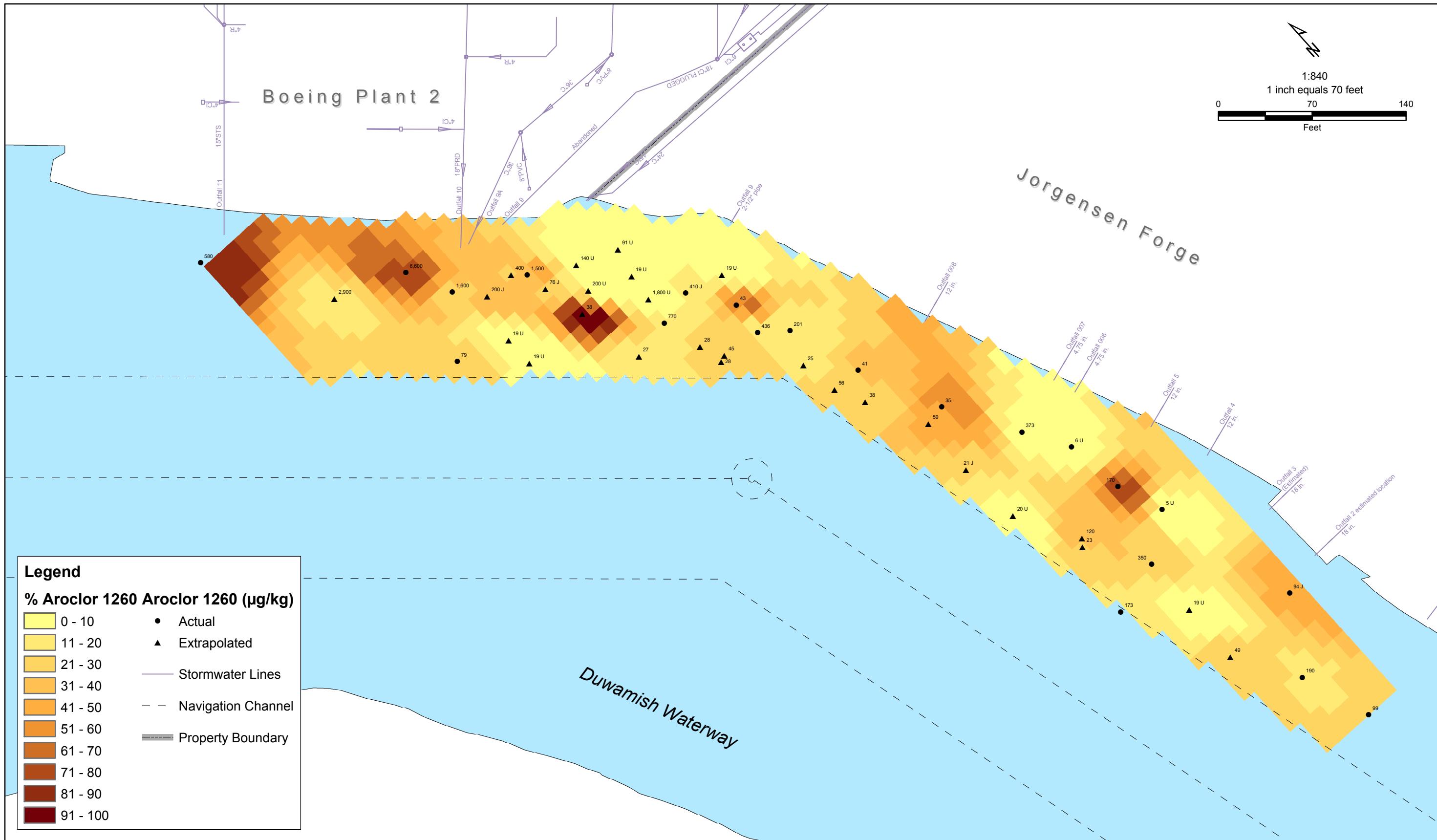
## **Interpolated Percentage of Aroclor 1260 in Total PCBs 1 - 2 ft Interval**



## Technical Workgroup

## **South Boeing Plant 2 and Jorgensen Forge Waterfront Seattle, Washington**

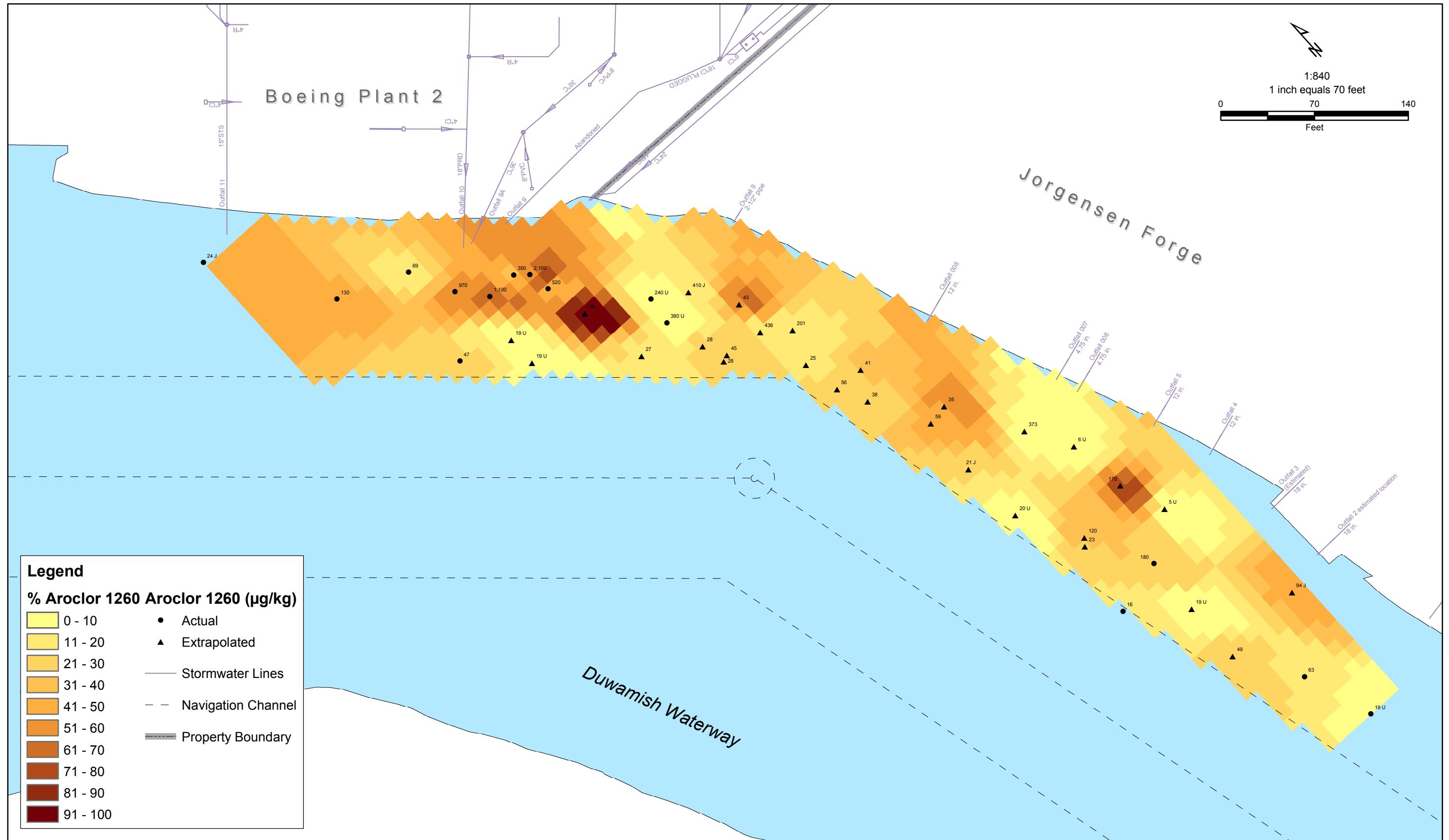
## **Interpolated Percentage of Aroclor 1260 in Total PCBs 2 - 3 ft Interval**



Technical Workgroup

South Boeing Plant 2 and Jorgensen Forge Waterfront  
Seattle, Washington

Interpolated Percentage of Aroclor 1260 in Total PCBs  
3 - 4 ft Interval



## **Technical Workgroup**

## **South Boeing Plant 2 and Jorgensen Forge Waterfront Seattle, Washington**

## **Interpolated Percentage of Aroclor 1260 in Total PCBs 4 - 5 ft Interval**

# Percentage of Aroclor in Total PCBs by Depth Below Mudline

